Knowledge.

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THE INDIAN EARTHQUAKE OF 1905.

By CHARLES DAVISON, Sc.D., F.G.S.

TWICE within eight years the Indian Empire has been visited by a destructive earthquake. On June 12th, 1897, one of the greatest disturbances of modern times, if not of all time, occurred in Assam and Northern Bengal. The shock was felt over an area half the size of Europe. Within a district twice as large as Great Britain, buildings were seriously damaged. In one that equalled the whole of Scotland, no house of brick or stone could withstand the violence of the shock. Even the form of the earth's crust was changed. Yet the loss of life was small—the total number of deaths was less than two thousand—for the earthquake occurred late in the afternoon, when the people generally were at work in the open air.

The more recent earthquake, which took place on April 4th, 1905, originated in the Kangra district of the north-western Himalayas. The area affected by it differed but little in magnitude from that disturbed in 1897, but the shock was far inferior in strength. Houses were damaged over a district only a little more than half the size of Yorkshire, complete destruction prevailed over an area not much larger than the county of Rutland. The earthquake, however, occurred shortly after six in the morning, before the general hour of rising, and consequently in the central districts the loss of life was serious. As the number of persons killed was more than eighteen thousand, the Kangra earthquake, though overshadowed by the catastrophe of Messina, must be regarded as one of the great disasters of the world.

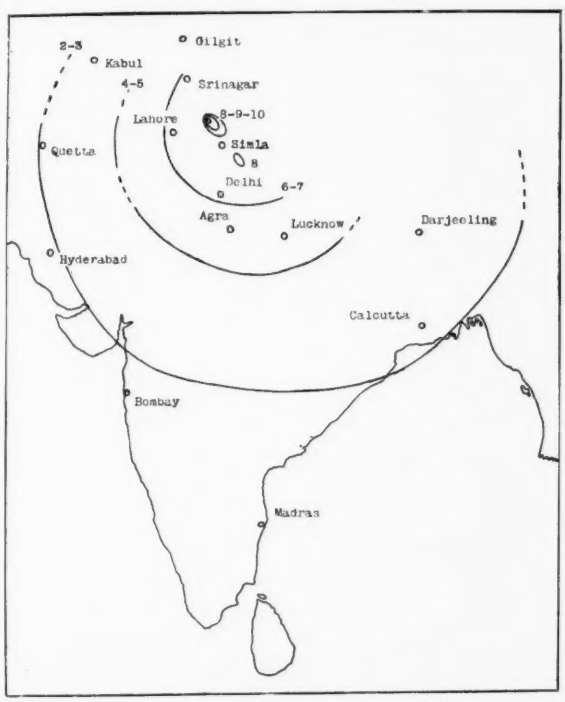

FIGURE 325.
The Area disturbed by the Earthquake.

We are indebted to Mr. C. S. Middlemiss, superintendent of the Geological Survey of India, for a detailed, if somewhat belated, account of this important shock. As soon as the extent of the disaster was known—and two days elapsed before it was fully realised—telegraphic instructions were issued to all officials in the area concerned to record in writing the exact time and other details of the shock. Letters were sent to the principal newspapers all over India, and forms of questions were distributed among the political officers and

residents of native states. Of still greater service was the personal inspection of the central district made by Mr. Middlemiss and three other officers of the Geological Survey. They collected many details from survivors, and examined the more durable effects of the shock on the ruined towns and villages.

The loss of life, as already noticed, was in great part due to the early hour at which the earthquake occurred. But there was another contributing cause —the sudden onset of the shock. It was at first supposed that no sounds or tremors heralded the coming disaster. Further inquiry showed that during the previous thirty hours, a few weak shocks were observed. There was nothing, however, to distinguish them from others which might occur alone. They attracted little, if any, notice, and in all probability they would have passed unrecorded had it not been for their disastrous successor. Practically, this broke without warning on the central area. The initial tremors must have been brief, for the death-rate at Kangra and Dharmsala was unusually high. From single-storeyed barracks and bazaars, the able-bodied had time to save themselves. From loftier dwellings, at least ten seconds, as Mr. Middlemiss estimates, would be required for escape. Yet even this brief interval was not vouchsafed their inhabitants. They had time to move, but not to escape, before the shock attained its full strength. In the Ghurka barracks at Dharmsala, in which one hundred and thirty-five men were killed, there were hardly any who had not left their beds.

The area disturbed by the earthquake is shown in the sketch map given in Figure 325. The curves are isoseismal lines—lines of equal strength of shock. It was found possible to draw six of these lines, the intensity of the shock being estimated by means of an arbitrary standard known as the Rossi-Forel scale. Near the central area the data are numerous, owing to the personal survey made by Mr. Middlemiss and his colleagues, and the map contains isoseismal lines corresponding to each of the three highest degrees of the intensity-scale. Outside the isoseismal line of intensity 8, the records were more scanty. They were furnished by persons who answered the inquiries in newspapers or filled in the earthquake-forms, and they depend on the personal impressions of observers, not on the more or less permanent effects of the shock. In drawing the isoseismal lines, it was found necessary to group together records of intensities 7 and 6, 5 and 4, and 3 and 2. All three outer lines are, however, incomplete. They traverse territory from which no observations were forthcoming. The outermost line of all includes the whole area within which the shock was sensible to persons at rest. If we imagine it completed in the course which its last observed trends seem to indicate, it includes an elliptical area about one thousand six hundred and fifty miles long, extending from Quetta on the west to beyond Calcutta on the east, and about one thousand five hundred miles from north to south. The total disturbed area, including the portion from which records are unobtainable, therefore falls but little short of two million square miles.

Of greater interest are the three inner isoseismal lines, the course of which it was possible to delineate with some approach to accuracy. These are shown on a larger scale in Figure 326. The innermost isoseismal of the three, includes an area of about two hundred square miles. Within it are such places as Kangra and Dharmsala, in which the destruction to life and property was sweeping. Only the strongest buildings, such as the Dharmsala magazine and treasury, were able to withstand the shock; ordinary houses were not only destroyed, they were reduced to flattened heaps of debris. The next isoseismal (No. 9) encloses the area of moderate destruction. Towns and villages were ruined, but not totally. A few well-built bungalows could afterwards be used in part as shelters, a room or verandah being here and there left standing. Others could be repaired by the renewal of portions of the walls and roofs. The difference between the two zones was very marked: in the former one wandered over the prostrate ruins of houses, in the latter between fragments of partly-standing walls.

Still less disastrous were the effects of the shock within the next isoseismal, that of intensity 8. Approaching it from the outside, sensible damage to buildings began to be plainly visible; but the damage was generally slight. It amounted to little more that a fallen roof or wall or a bulging tower, damage that was so easily repaired that the inhabitants soon returned to their houses. The most remarkable feature of the isoseismal is its division into two detached portions, between which the intensity of the shock was manifestly less. The larger portion surrounds the isoseismals 9 and 10 the smaller includes Dehra Dun, Mussoorie and other places. The centres of the two curves are about one hundred and twenty miles apart in a north-west and south-east line, while the longer axes of the curves are roughly parallel.

The rate of decline in intensity in various directions from the central area is clearly shown by the form and relative positions of the isoseismal lines. These curves also bound areas within which the nature of the shock distinctly varied. From within the central isoseismal, it was found difficult to collect any personal observations. Nearly half of the inhabitants were crushed beneath fallen buildings, the majority of the survivors were unnerved by terror. The few records available show, however, that the shock was very different from that usually experienced during earthquakes. At Dharmsala there were a few gentle tremors, followed by two or three severe shocks, the second of which was the most disastrous. So far as can be judged from the personal evidence, the shocks consisted of "a mass movement in a horizontal direction and back again —not so much a fierce shaking as a drag of the ground in one direction and then in another like the wash and back-wash of a wave on shore." In the

words of one observer, "the houses lurched forward with violence and came down as if made of cards."

In the next zone, that between the isoseismals 10 and 9, the nature of the earthquake changed to a single forward thrust. There appear to have been no preliminary tremors, but simply one great vibration, which increased in violence to a maximum and then died down. The earth is said to have moved in waves, while trees swayed to within a few feet of the ground, and it was difficult for anyone to stand upright. The duration of the shock, as taken by a stopwatch, was one and a quarter minutes.

In the detached portion of the isoseismal 8, which includes Dehra Dun and Mussoorie, the shocks were of the usual vibratory character. They began with tremors or quiverings lasting for several seconds, like those caused by a dog scratching itself under the bed. Then came a pause of a few seconds, followed by two or three violent oscillations or groups of stronger vibrations, the whole lasting for one or two minutes. That the shock was still strong is evident from such descriptions as "an irregular motion, the observer being jerked from side to side, and then all round" or "as if taken by the shoulders and shaken violently." Persons were unable to stand or walk properly, trees swayed and tents rocked as if in a gale. Then the shocks died away gradually as they had begun.

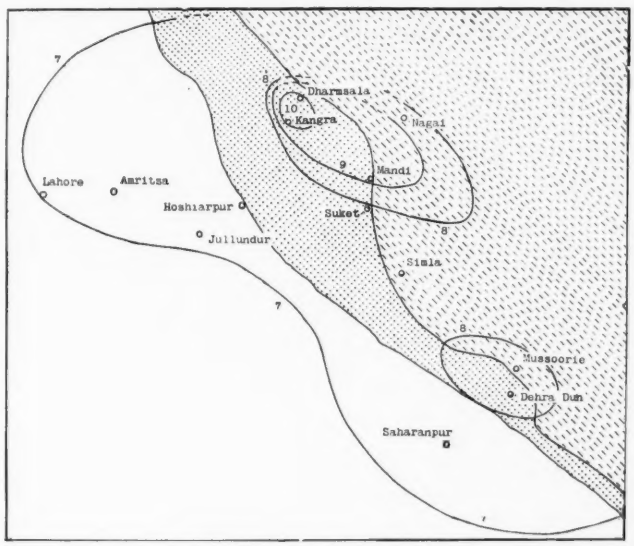

FIGURE 326. Isoseismal Lines.

With still increasing distance, the fierceness of the shocks declined. Rapid vibrations, of three or four a second, were manifest within the next two zones, but the great oscillations of the central area were smoothed down into a slow rolling or undulating motion, such as is felt on board a steamer in a moderate sea or in an open boat at sea. By the time the earthquake reached the outermost zone of all, that in which the shock was just sensible, the quick vibrations were all quenched, there was merely a gentle rocking of beds, water in tanks swayed, and in very distant places the bubbles in the tubes of levels were seen to oscillate.

In one respect, the Kangra earthquake differed from others of equal or greater violence—there is no visible evidence whatever of deep-seated changes in the earth's crust. In such earthquakes as those of Mino-Owari (Japan) in 1891 or Assam in 1897 or California in 1906, the fractures or faults along which the originating movement took place were continued up to the surface. Along these fractures there were displacements, both vertical and horizontal. Rivers were ponded back so as to form lakes, roads and boundary-fences were severed and their shifted ends were left standing several yards apart. In places, the crust was so compressed that allotments were reduced in width. The form of the surface was changed so that distant objects, formerly hidden by intervening mountain-spurs, became visible. In the Kangra and Dehra Dun districts, there were none of these changes. "Not a single railway has recorded any damage to the track, not a single road or path has been deflected, raised or lowered, no rivers or streams have changed their courses or been temporarily dammed up — except as due directly to landslips." Surface fissures of course there were in abundance in loose friable ground, but in no case did they differ from those which might be produced by a violent shaking. The distribution of damage within the central areas is also uniform; there is no tendency to grouping along lines of exceptional destruction.

All this seems to indicate that the focus of the earthquake was unusually deep-seated. How great the depth was we have no sure means of ascertaining. Mr. Middlemiss has endeavoured to form an estimate by employing a method which Major Dutton devised in his investigation of the Charleston earthquake of 1886. According to this method, the depth of the focus is about one and three-quarter times the distance of the region in which the intensity of the shock varies most rapidly from that which lies vertically above the focus. The method, if correct in principle, would be difficult to apply. The intensity of the shock is subject to so many abrupt variations that it is hardly possible to locate the band in which the rate of change is greatest. Moreover, the method takes no account of the loss of energy, as the waves traverse the superficial layers of the crust. We cannot, therefore, feel much confidence in Mr. Middlemiss' estimate that, in the neighbourhood of Kangra and Dharmsala, the depth of the focus must be between twelve and twenty-one miles, while, about fifty miles farther to the east-south-east, it must be between about twenty-one and forty miles. All that we can feel sure of is that the depth of the focus was considerable, and that

the movements within it which caused the earthquake died out practically before reaching the surface.

In the absence of crustal deformation, it would be too much to expect that a re-survey of the central districts would show any appreciable change of level, and, if any could be detected, the district which includes Dehra Dun and Mussoorie would naturally show less than that which includes Kangra and Dharmsala. Unfortunately it is only for the former district that any previously-made line of levels is available. In 1862 the line from Saharanpur, through Dehra Dun, to Mussoorie was levelled. In 1904, less than a year before the earthquake, the portion from Dehra Dun to Mussoorie was repeated, and again a year later, or about a month after the earthquake. The last operation showed that either Dehra Dun had risen about five inches with respect to Mussoorie or that Mussoorie had sunk the same amount with reference to Dehra Dun. There may also have been movements of both places. A fresh series of levels was, therefore, carried out along the whole line from Saharanpur to Mussoorie in the cold weather of 1906–7. These corroborated the work of 1905, and proved that Dehra Dun had risen about five inches, that is, regarding the height of Saharanpur as fixed, while the position of Mussoorie was almost unchanged. The amount is a small one, but every precaution to avoid error was taken, and, as the change occurred between May, 1904, and May, 1905, it seems reasonable to conclude that one result of the deep-seated movements which caused the earthquake was this very slight buckling upwards of the crust.

The nature of these deep-seated movements is obscured both by the absence of crust-deformations and by the want of precise observations in the central area. They appear, however, to have taken place within two detached regions, one below Kangra and Dharmsala and stretching in an east-south-east direction for fifty miles or more, the other, below Dehra Dun and Mussoorie, of much inferior length. The axes of the two detached isoseismals being roughly parallel, it may be inferred that the foci were also elongated in the same direction, though not in the same line. The total length of the complex focus, including the break in the neighbourhood of Simla, must have been about one hundred and fifty miles. Throughout its whole extent the disturbance must have taken place almost simultaneously. Had it been otherwise, two great shocks would have been felt at Dehra Dun, one coming from the focus below, the other from the more important focus near Kangra. There may, however, have been an interval, amounting to a considerable fraction of a minute, between the disturbances in the two foci, that in the Dehra Dun focus being precipitated by the increased strain brought into action by the movement within the Kangra focus.

Though we cannot picture the movements which caused the Kangra earthquake so clearly as in the case of the San Francisco earthquake of the following year, the earthquake certainly belongs to the great class of tectonic shocks, those which are the result of the moulding operations that still take place within the Earth's crust. The nature of the shock within the greater central area, where it was manifested as a shift rather than as a vibratory movement, points to an actual displacement of the surface-crust, even though no permanent trace of it was left. There can be little doubt that the displacement was the last of those movements which culminated in the uplifting and growth of the Himalayas. This great range runs in an even circular arc, with its convexity towards the south. The Kangra earthquake occurred in the part where strong shocks are most frequent in such ranges, namely, on the convex steeply-sloping side.

Mr. Middlemiss points out a remarkable relation between the two foci and the geological structure of the district. The principal features of this structure are represented in the sketch-map (Figure 326). The area indicated by diagonal shading is occupied by the old Himalayan rocks. Bounding it on the south-west is a band, shown by dotted shading, consisting of the younger Tertiary formation of the Sub-Himalaya. To the south-west of this, again, the whole region is covered with alluvium. Between the Tertiary rocks of the Sub-Himalaya and the older Himalayan formations, there runs a great boundary-fault, which, just to the north of Dharmsala, bends rather sharply to the east, and, after sweeping in a great curve round the foot of the Simla mountain spurs, returns to its normal direction. This direction is maintained until near Mussoorie, when it again bends to the east, sweeps round in the same way as before, past Dehra Dun, but in a smaller curve, after which it once more resumes its normal direction. "Nowhere else along the Himalayan mountain-foot, as we know it," says Mr. Middlemiss, "is there such exceptional irregularity, unevenness one might say, in the disposition of these bordering bands of Tertiary strata."

Now, as will be seen from Figure 326, the two earthquake centres lie in the Sub-Himalayan band, nearly but not quite along the line of the great boundary-fault, and precisely in those parts where the band widens and invades the older Himalayan mass. Moreover, the main centre lies in the larger bay, and the secondary centre in the smaller. Mr. Middlemiss further notices that the regions occupied by the earthquake centres are both "regions of reversed faulting, where a packing of the strata and an overriding of the younger by the older rock series is specially prominent. They coincide with parts of those regions where there is irregularity in that packing, and where the regular marginal arc of the mountain, as expressed in the parallel earth folds and faults, is interrupted."

The place of the Kangra earthquake among other destructive shocks is not easy to determine. Loss of life and injury to property are fallacious guides. The one depends on the time at which the shock occurs, the other on the construction of the buildings and the nature of the materials employed.

If we were to measure the strength by the area disturbed, the Kangra earthquake would have to be regarded as among the greatest of all recorded earthquakes, as superior to the Japanese earthquake of 1891, as roughly equal to the Assam earthquake of 1897, yet as inferior to the much less disastrous earthquake of Charleston in 1886. The extent of the area of complete destruction is a more trustworthy standard. Measured in this way, the Kangra earthquake falls far short of the Assam earthquake of 1897. The most satisfactory test of all, however, is the intensity of the shock within the central area, but this is known precisely in the case of only a few recent earthquakes. At Dharmsala, the shock was distinctly stronger than the Californian earthquake at San Francisco in 1906 or the Calabro-Sicilian earthquake at Messina in 1908. At Kangra it was nearly twice as strong as at either of these places. But, even at Kangra, the intensity was less than that of the Japanese earthquake of 1891 in the Mino-Owari plain, and was not to be compared with that of the same earthquake in the crushed and distorted rocks of the Neo Valley.

In its destructive effects, the Kangra earthquake reiterates the lesson which governments are so slow in learning. Thickness of wall alone is no safeguard; it may be a source of weakness. With inferior material and no frame-bindings, such a mass is at once shattered by an earthquake shock, as in the barracks at Dharmsala, where many Ghurka soldiers were killed and wounded. In the Kangra valley, ordinary buildings had walls of mud or rubble masonry surmounted by a heavy slate roof. Few structures could offer less resistance to an earthquake, the result being that more than a hundred thousand houses were destroyed in Kangra and the surrounding country. Mr. Middlemiss considers that it would be useless to urge the construction of earthquake-proof houses or to discountenance building on ridges or mountain-spurs. Disastrous earthquakes, he remarks, are isolated occurrences, and it is economical to make use of materials close at hand, and convenient to follow familiar styles of building. But the government that urged such reasons for inaction might with equal justice neglect to insure their property against fire, or to prepare for a foreign war.

THE OPTICAL CONVENTION, 1912.

This convention was held in the Science Museum, South Kensington, from June 19th to the 26th, under the presidency of Professor Silvanus P. Thompson, D.Sc., F.R.S.

The objects of the conference were to investigate how theory can further industrial development, and how practical problems may direct theoretical investigation; to discuss the better organisation of the British optical industry, and the improvement of British optical manufactures; and to ascertain and make known existing wants and deficiencies. The exhibition held in connection with the conference was designed to show the resources of British manufacturers of optical appliances.

Messrs. Reynolds & Branson, Ltd., exhibited a special adjustable front stage for the Stroud & Rendell optical lantern, which enables an ordinary microscope, with the eyepiece removed, to be used for projection.

A new type of sunshine recorder was shown by the Cambridge Scientific Instrument Company—Callendar's Bolometric Sunshine Receiver. This consists of two platinum resistances mounted on a mica framework, hermetically sealed up in a glass bulb filled with dry air. One of the resistances is blackened, the other is left bright. The two are connected in the opposite arms of a recording Wheatstone Bridge. When radiant heat falls on the receiver, the blackened resistance absorbs more heat than the other, its temperature rises and the recorder is thrown out of balance. On the usual clock-driven drum these variations are marked, indicating not only the number of hours of sunshine, but also the intensity of the radiation in absolute units.

The same firm also showed an improved form of Thomson Galvanometer invented by Professor Paschen, which is many times more sensitive than the normal form.

Mr. R. W. Munro has designed an anemograph which records, on a single chart, wind pressure, as well as direction and time. This should replace the expensive double instrument at present employed.

Messrs. Raphaels, Ltd., have evolved handy instruments for measuring any muscular imbalance of the eyes in the Maddox Near Vision Phorometer and in the Micro-telescope, a useful combination of the telescope and microscope giving magnifications of 12 and 20 diameters respectively.

A very interesting loan collection was also on view, including a Star-Photograph Micrometer, many early types of microscopes, a camera lucida formerly belonging to Dr. Wollaston, a little Dumpy Reflector Telescope made by James Watson in 1794 of very perfect figure with both Gregorian and Cassegrain, an original Nicol Prism by William Nicol and one of Fraunhofer's prisms.

The catalogue will be useful as a record of the various types of instruments made by British manufacturers in the different branches of optical science.

H. H. P.

Among the papers read at the recent Optical Convention there are some which are of considerable interest to the general public, who are not, as a rule, concerned with the manufacture or use of optical instruments other than the eye and spectacles. Dr. M. von Rohr, of the Zeiss works at Jena, dealt with the form of spectacle lenses designed to give a field of "direct vision": in other words to enable the wearer of the glasses to transfer his gaze from one object to another by simply rolling his eyes without moving his head, and this without any loss of distinctness of vision. Another paper by Messrs. Dow and Mackinney on "Some Recent Advances in the measurement of light and illumination" describes some methods which should help to popularize such measurements. Thus, in choosing a wallpaper for the drawing room, we should not allow ourselves to be content with a surface brightness of less than 0·3 foot candles. For the library or the dining room we may be prepared to accept very much less than this. If we provide ourselves with a holophane lumeter and a celluloid test-card, we can easily discover whether the samples of wallpapers submitted to us by the builder come up to our standard. A paper on the design and construction of large Polariscopes by Professors Coker and S. P. Thompson, will be of interest to those who saw, at a recent Soirée of the Royal Society, the wonderful double-refracting effects produced by varying stresses in certain celluloid models. A paper on errors of observation by Messrs. Baker and Bryan will be of interest to naval officers and all who make use of the sextant and prismatic compass.

W. D. E.

XUM

IS MATTER INDESTRUCTIBLE?

By H. STANLEY REDGROVE, B.Sc. (LOND.), F.C.S.

WHEN a candle burns it ceases to exist as such. Closer examination of the phenomenon, however, shows that this is not all that occurs. Not only does the candle disappear, but some of one of the constituents (oxygen) of the atmosphere is used up; and in the place of the candle and oxygen, new gases (carbon-dioxide and water-vapour) make their appearance. If all these bodies are carefully weighed at the same spot on or above the earth's surface, it will be found that the combined weights of the carbon-dioxide and the water produced are exactly equal to the combined weights of the candle and oxygen consumed. A similar statement holds good of every other chemical change; the combined weights of all the bodies produced during such a change is always found to be exactly equal to the combined weights of all the bodies consumed.

Now, the weight of a body is the force by which it is attracted to the earth's centre; thus, the force pulling a two-pound weight to the earth's centre is twice that acting on a one-pound weight at the same place. Force is sometimes defined as that which produces or tends to produce motion. It appears, however, that force is one of man's primary conceptions, and as such, is undefinable, since the idea of force cannot be resolved into simpler ideas; but even as a description of force or of its effects the above statement is not altogether satisfactory. In order to keep a body moving with uniform velocity over a rough surface, force must be continually applied to it. But this force is needed to overcome friction, itself a force which constantly tends to decrease the rate of the body's motion—that is, to impart to it a retardation or negative acceleration. If more force than that required to overcome friction is constantly applied to the body, it will move with ever-increasing velocity—that is to say, the force will impart acceleration to the body. Moreover, with the reduction of friction by any means, such as by the use of a lubricant or by replacing the rough surface by a smooth one, less force is needed to keep the body moving with a given uniform velocity. The conclusion is justified, therefore, that could a perfectly smooth body be procured, no force would be needed to keep it moving with uniform velocity over a perfectly smooth surface; though force would be needed to *start* the body so moving—that is, to impart the acceleration to the body necessary to increase its velocity from zero to that velocity with which it is required to move. It follows, therefore, that force may be more accurately described than by the definition already given as that which produces or tends to produce acceleration (either positive or negative), or what is the same thing, *change* of motion.

If no forces whatever are operative on a body, it will remain in a state either of rest or of uniform motion: to change this state force is necessary. This fact is expressed by saying that the body possesses *inertia*. Inertia may, therefore, be defined as that property of a body in virtue of which it tends to keep in a state either of rest or of uniform motion, and will remain in this state unless and in so far as force is applied to it. Now, in order to produce a given acceleration (or change of state of rest or uniform motion) in different bodies, experiment shows that different forces are necessary. Thus, in order to accelerate two pounds of iron one foot per second per second (that is, to increase its velocity one foot per second every second), twice as much force is necessary as is needed to accelerate one pound of iron one foot per second per second. This fact is expressed by saying that the inertia of two pounds of iron is twice that of one pound of iron. That is to say, the inertias of bodies may be measured by applying to them (for the same period of time in each case) such forces as are necessary to impart to them a given acceleration: the forces applied will then be proportional to the inertias of the bodies.

Now, if various bodies are dropped from the same heights above the earth's centre, and if the friction due to the air is obviated, by using a vacuum or otherwise—that is to say, if various bodies are allowed to move under the influence only of their respective weights—it will be found that they will all fall with the same constant acceleration, no matter what their size, shape or weight may be.* This acceleration is called *g*, and is, approximately, thirty-two feet per second per second. Since the only force operative on each body is its weight, and since the acceleration is in all cases the same, it follows that the weights of bodies determined at the same point relative to the centre of the earth are proportional to their inertias.

It has already been pointed out that the sum of the weights of all the bodies produced by a chemical change is exactly equal to the sum of the weights of all the bodies consumed therein, so long as all the weights are determined at the same place on or above the earth's surface. If in place of "weights" in this statement the word "inertias" is substituted, the reservation may be deleted, and the inductive law may be formulated that chemical action has no

* This may be demonstrated by means of the following very simple experiment. Place a small piece of paper on top of a penny (the paper must be smaller than the coin); allow them to fall together; the result will be that they will both reach the ground at the same time. The reason for placing the paper on top of the coin is that by this means the paper is protected from the retarding influence of the air, which is much greater in the case of the paper than it is in that of the coin.

effect upon inertia. This is the law of the conservation of inertia.

This law is very frequently termed the law of the conservation of mass. It used to be known as the law of the conservation or indestructibility of matter, and this expression is still occasionally met with. The first of these expressions is objectionable because, although "mass" is generally used by modern physicists in the sense of "inertia" as defined above, at one time it was held to signify the "quantity of matter in a body." "Mass," therefore, is an ambiguous term, and ought to be avoided, since the word "inertia" accurately expresses its modern connotation without ambiguity.*

With the second of the above expressions we have now to deal. The word "matter" is exceedingly ambiguous.† By a certain school of metaphysicians, who may be termed materialists, the word "matter" is used to denote a hypothetical thing-in-itself, a "substance" supposed to underlie all the phenomena of the physical universe. This metaphysical use of the word at once places it outside the domain of pure science, since science is only concerned with phenomena as such. It is, of course, obvious that the law of the conservation of inertia affords no ground for asserting the indestructibility of matter so defined. According to the materialistic hypothesis, matter is known to us not only by its inertia, but by all those other phenomena which are termed (in accordance with this hypothesis, and loosely by those who do not hold it) "properties of matter." Surely, then, the "quantity of matter" in a body is not to be measured merely by the inertia of the body, but rather by the sum of all its "properties." The argument that the "quantity of matter" must be measured only by the inertia, since all the other "properties" of a closed material system are variable, the inertia of such alone being constant, is a flagrant *petitio principii*, since it assumes the very point at issue, namely, the indestructibility of matter. Indeed, since materialistic philosophers always postulate *extension*, or the property of occupying space, as the most fundamental "property of matter," it would seem that the "quantity of matter" in a body ought to be measured, if by one "property" alone, by its *volume;* and the volume of a body is by no means constant. The volume of bodies, as is well known, can readily be altered merely by the application of pressure or by a change in temperature; moreover, the volume of a reacting system is not usually constant during a chemical change.

By another, and less speculative, school of philosophers the term "matter" is used merely to connote the fact or, perhaps we should say, law that certain phenomena (the so-called "properties of matter") are always found grouped together so as to form a complex, which may be termed a "material body"; and it is now becoming more completely realised that the term "matter" ought to be employed in purely scientific writings only with some non-metaphysical meaning such as this. If the term is used in this sense, there is evidently no justification for supposing that matter is indestructible because inertia is conserved. For, thus employed, "matter" stands for many phenomena, or "properties," or rather for the fact or law of their connection; not merely for that particular phenomena or property termed "inertia."

No alleged scientific evidence has ever been brought forward in favour of the doctrine of the indestructibility of matter, save the facts generalised under the expression "the law of the conservation of inertia." Now it is evident that these facts can only be regarded as evidence of the truth of this doctrine, if it can be proved that the matter of a body (in whatever sense the word "matter" is used) is identical with, or measured by, the inertia of the body. Nothing, however, has ever been advanced to prove this, and as must be evident from what has been already said, it is most unlikely that any such relation between matter and inertia holds good. Moreover, if it were maintained that "matter" ought to be defined as "inertia," the obvious reply is that this would be contrary, not only to the ordinary usage of the word, but also to its use by philosophical writers generally.

But to consider even unlikely possibilities, were it proved that the inertia of a body does, in fact, measure the "quantity of matter" it contains, or were it generally agreed that the word "matter" ought to be employed as synonymous with "inertia," the case for the doctrine of the indestructibility of matter would in no way be improved. For Professor Sir J. J. Thomson has proved mathematically that an electrically-charged particle in motion possesses inertia in virtue of this motion, and that if its velocity is sufficiently high, an increase in the velocity produces a considerable increase in its inertia. This has been experimentally verified by Kaufmann, who measured the inertias and velocities of the small particles emitted by the disruption of the atoms of radium. He found that the greater the velocities of these particles the greater were their inertias, the observed increment in every case agreeing with that calculated according to Thomson's reasoning. It is evident, therefore, that although inertia is conserved during chemical action, the inertia of an electrically-charged body may be altered by sufficiently accelerating it. If then, "matter" is the same thing as inertia, or is measured thereby, it is evident that matter may be created by sufficiently accelerating such a body, or destroyed by retarding it.

* For a further discussion of the ambiguity of the word "mass," and its bearing on the philosophical doctrine of materialism, see the chapter "On the Indestructibility of Matter" in the present writer's "Matter, Spirit, and the Cosmos" (Rider, 1910).

† Compare Professor Ostwald's remarks on the use of the word "matter" in his "The Fundamental Principles of Chemistry" (trans. by H. W. Morse, 1909), §§ 7 and 10.

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It is evident, therefore, that, at the best, the doctrine of the indestructibility of matter is a pure hypothesis, entirely unsupported by scientific evidence: indeed, so far as we can see, contradicted thereby. This fact is very generally recognised by physicists now-a-days*, but many people still believe that the doctrine of the indestructibility of matter is a law of the highest scientific importance, supported by the most convincing evidence. It is nothing of the sort. The expression "law of the indestructibility of matter" does figure largely in old scientific text-books, but it is quite a mistake to suppose that this so-called "law" is one of the foundation-stones of modern science. The law of the conservation of inertia, which is true under all but the most exceptional conditions, and which is a generalised statement of observed facts involving nothing hypothetical, suffices for all the purposes of the natural sciences for which the hypothetical "law of the indestructibility of matter" was at one time employed.

* Cf. Professor H. C. Jones, "The Elements of Physical Chemistry" (1902), p. 2.

EVERYMAN'S ASTRONOMY.

By DR. ALFRED GRADENWITZ.

MORE and more attention is paid to astronomical instruction in the curriculum of grammar schools, and some German "Gymnasia" have even gone so far as to install observatories of their own. As, on the other hand, the number of amateur astronomers is rapidly increasing, there is obviously a need for designing special instruments for lay people which, while warranting a sufficient degree of accuracy, may enable anybody without mathematical calculation to get a clear insight into the topography of the heavens.

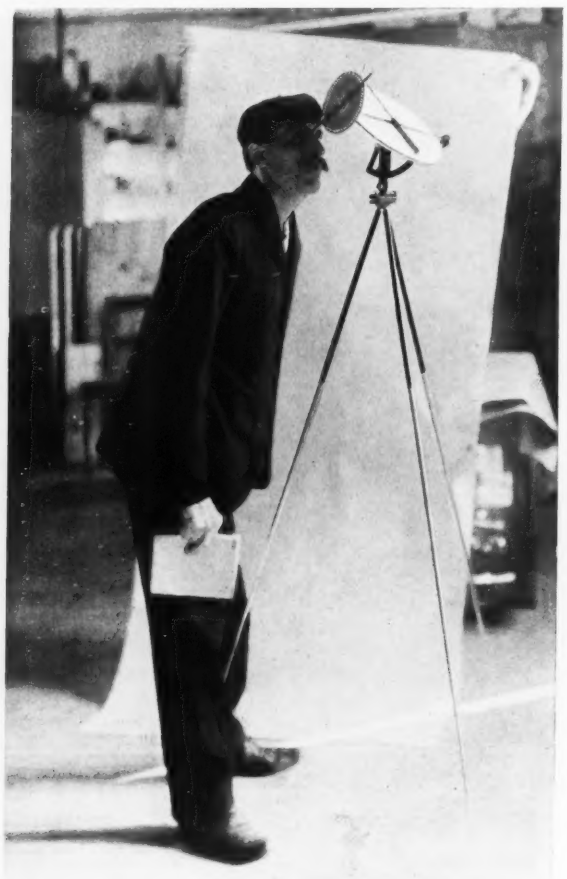

FIGURE 326.

The New Star Finder.

A German instrument maker, F. Sartorius, of Göttingen, has designed a "star-finder," an astronomical instrument of surprising simplicity and remarkable precision, which enables any layman to ascertain the name of any star observed in the sky and the constellation to which it belongs or, inversely, to find out any given star from its name and position. Its design is based on the following considerations:

The position of a star in the sky is known to be defined by two angles, *viz.*, rectascension and declination, corresponding to the geographical longtitude and latitude respectively of points on the globe. Again, orientation in the sky, the same as on the earth, should be based on the North-South direction of the magnetic needle. This is why the star-finder primarily comprises a compass.

The star-map which forms an indispensable part of any instrument of this kind, should be adjustable parallel to the equator which serves as basis in determining the latitude and longitude. The horizontal position of the axis round which the star map is free to rotate, therefore, is ascertained by a level, and a graduated circle allows the map to be adjusted to the geographical latitude of any given locality. Now, all stars and constellations in their apparent twenty-four hours' revolution, due to the rotation of the earth, are known to advance each hour an always constant distance, their angle with regard to the initial meridian changing progressively. On the other hand, on account of the revolution of the Earth round the Sun, the point of the sky which at noon or at midnight occupies the highest position or passes through the meridian, advances about one degree (360/365) in a western direction: that is to say that the stars in their turn perform a progressive motion from East to West.

These principles are utilized so cleverly in the star-finder that a few manipulations, without any mathematical calculation, suffice to find out any star desired.

Round the centre of the star-map there are free to turn two rectangular arms, one of which carries at its end the graduated declination circle. On this circle rotates a diopter, which is pointed towards the star and which by its position on the graduated circle, immediately indicates the declination of the former. The rectangular arm carries, at right angles to the diopter axle, a disc, which in its turn, on the inside hours' graduation of the star-map, indicates the rectascension of the star. The graduation of this disc agrees with that of the declination circle, so that the star towards which the instrument is pointed is read directly below the division of the graduated disc marked by the diopter on the declination disc.

The inside hours' graduation is surrounded by another dial (diurnal and monthly), which in its turn is adjusted with regard to the fixed outside hours' graduation. This allows the star-map to follow the apparent progression of stars, the hourly advance being continually accounted for.

THE CANADIAN RUFFED GROUSE.

By CHARLES MACNAMARA.

THE Canadian Ruffed Grouse (*Bonasa umbellus togata*), popularly known as the "partridge," is one of our most widely-distributed game birds, being found wherever there are woods, from New Brunswick to British Columbia, and as far north as Hudson's Bay. It is a handsome grayish bird of markedly gallinaceous appearance, some seventeen inches long and of stout build. The extraordinary "drumming" noise made by the male bird to call the female is familiar to everyone who frequents the woods in the spring. To produce this remarkable sound the bird stands on some slight elevation, such as a log or a stone, and strikes the air strongly with his outstretched wings. The first four or five strokes, occurring at intervals of about half a second, sound like blows on a rather dull bass drum, but they rapidly get faster and faster until the sound becomes continuous like the roll of a snare drum. The whole performance lasts, perhaps, ten seconds, and is repeated every few minutes for some time.

In the northern part of its range this bird has another peculiar habit: that of tunnelling into a snowdrift for protection against the intense cold. In order to begin its tunnel it sometimes walks around, deliberately burrowing here and there into the snow with its head until it finds a suitable place, but its general procedure is to dive from an elevated branch or directly off the wing into the drift, the momentum of its plunge being sufficient to drive it some little way into the soft snow, and thus enable it to start its tunnel conveniently. Then, at a depth of three or four inches under the surface, it scratches out a horizontal or slightly descending passage about two feet long, the end of which it enlarges into a roughly spherical chamber eight or ten inches in diameter, the removed snow completely blocking up the entrance tunnel. Here the bird, apparently preferring hunger to cold, may spend several days if the weather is severe. Except for the one mark where the tunnel begins, the surface of the snow is quite undisturbed, and no one would ever suspect that a live warm bird was concealed in the drift. To leave its burrow, the bird simply bursts out through the overlying layer of snow, springing into immediate flight.

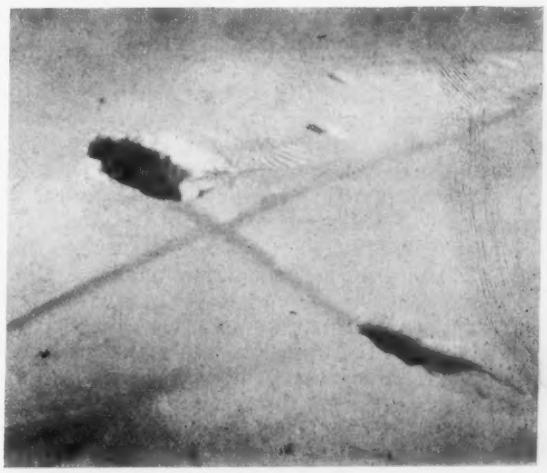

FIGURE 328.

The Snow Burrow of the Canadian Ruffed Grouse.

At the lower right hand corner is the entrance to the burrow. In this instance, the roof of the tunnel has sunk slightly, so that its course can be traced on the surface. The hole to the upper left hand is the terminal chamber, out of which the bird has burst. The mark of its wing can be seen on the snow to the right of the hole.

FIGURE 327.

The Canadian Ruffed Grouse (*Bonasa umbellus togata*).

One day last January, when the thermometer stood 10° below zero F., I stopped a moment while snowshoeing through the woods to examine a curious isolated mark on the snow. At that instant a "partridge" burst out just at the toes of my snowshoes, and with a great whirr of wings disappeared among the spruces. The mark I had noticed was the entrance to the tunnel, and from its appearance the bird had evidently been three or four days in its burrow, and would doubtless have remained there longer if my approach had not frightened it out. Dry soft snow is, of course, an excellent non-conductor of heat, and even in the very coldest weather, the ruffed grouse is no doubt quite comfortable in its immaculate chamber.

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THE FERTILISATION OF THE FIG.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

MUCH has been written, from the time of the earliest Greek naturalists to the present day, concerning the fertilisation of the fig, but it would appear from some recent researches that the problem is by no means cleared up yet, and that the process is one of great complexity, involving one of the most astonishing examples of symbiosis, or mutual relationship between organisms, that has ever been disclosed.

The genus *Ficus* is an extensive group belonging to the family Moraceae, which includes also the mulberry, and which is related closely to the nettle and elm families. Besides the various kinds of figs, *Ficus* comprises among its six hundred species, which are chiefly indigenous to the East Indies and Polynesia, such well-known plants as the indiarubber tree, the banyan, and the peepul.

The edible fig of commerce *(Ficus carica)* appears to be native in Asia Minor and Syria, but now grows "wild" in most of the countries around the Mediterranean. Doubtless owing to the ease with which its nutritious fruit can be preserved, the fig was probably one of the earliest plants to be cultivated. According to Herodotus, the fig was unknown to the Persians in the time of the first Cyrus, but it must have spread in remote ages over all the countries around the Aegean and the Levant. Apparently the Greeks received the fig from Caria, whence the specific name, but they improved the fruit so much by cultivation that Greek figs became celebrated throughout the East. From Greece, at some prehistoric time, it was taken to Italy, where numerous varieties, mentioned by Pliny, arose under cultivation. The fig is now grown in all the Mediterranean countries, but the greater portion of our supply comes from Asia Minor, Spain, and the south of France. It was introduced into England from Italy by Cardinal Pole in the sixteenth century, and is grown for its fresh fruit in all the milder parts of Europe and the United States, though farther north it requires protection in winter and a south wall for its successful cultivation out-of-doors.

In the fig, as in other species of *Ficus*, the flowers are produced inside a hollow pear-shaped receptacle opening by a narrow pore at the top. Just below the mouth, in most species, are the male flowers, while the rest of the cavity is lined by the closely packed female flowers. The individual flowers are small and of simple structure, the male having only one or two stamens and the female a small ovary with a slender style at its apex.

It has been known for some time that the flowers of *Ficus* are fertilised by means of small wasps called *Blastophaga* and *Sycophaga*. The female wasp enters a fig and lays its eggs in the ovaries of the female flowers; this occurs at an early stage, when the stamens of the male flowers have not yet opened. The male wasps arising from these eggs fertilise the females, and as these emerge from the opening of the receptacle they are dusted with pollen from the male flowers, and carry the pollen to other inflorescences.

According to more recent investigations, however, the story of the relation between the wasp and the fig-tree is longer and more involved than this simple statement would imply. Tschirch* has recently published a memoir on the wild and cultivated figs of Italy, based chiefly upon extensive observations made by the Italian botanist Ravasini. Apparently there are three forms of *Ficus carica*—(1) the wild fig itself, (2) the male plant or Caprificus (*Ficus carica α caprificus*), and (3) the female fig (*Ficus carica β domestica*). The two cultivated forms, male and female, are varieties which have arisen from the original wild fig; the *caprificus* form, being functionally male, of course produces no seeds, while the seeds produced by the *domestica* form give rise to seedlings which revert to the wild fig.

The wild fig produces three generations or crops of inflorescences. (1) The "profichi," appearing in February or March and ripening in June, contain only male flowers and short-styled female flowers which produce no seeds, and are not edible. (2) The "fichi," appearing at the end of May on the lower parts of the branches and ripening in September, contain long-styled fertile female flowers, and are edible. (3) The "mamme," appearing in September on the young shoots and ripening in March or April of the following year, contain only the short-styled flowers producing no seeds, and are not edible. The "profichi" constitute the male generation; they remain hard and contain little or no sugar, and are usually filled with the wasps—*Blastophaga grossorum*. The "fichi" form the female generation, producing seeds and becoming fleshy and sweet. The "mamme," which remain quite small, serve only to harbour the wasps during the winter; they wither and fall off in spring when the insects have escaped.

The female wasp enters the "mamme" in autumn and deposits her eggs in the short-styled flowers, stimulating these to grow into "gall-flowers," containing a larva instead of a seed. Tschirch states that these flowers contain an undifferentiated mass of tissue instead of a normal ovule or "young seed," but according to other writers an ovule is present though it does not ripen into a normal seed; in any case, these flowers are specially adapted for the nursing of the wasp larvae, since the female wasp is able, owing to the shortness of the style surmounting the ovary, to penetrate the latter with her ovipositor

* *Berichte d. deutsch. bot. Ges., XXIX.*

and thus successfully lay her egg in the nutritive tissue of the ovary. The young insects, male and female, arising from the eggs, remain inside the "mamme" during winter. The male wasps, which are wingless, never escape from their prison, but fertilise the females *in situ*, and in spring these females creep out of the inflorescence and enter the "profichi," the male flowers of which are not at this time mature. Here they lay hundreds of eggs in the female flowers, occupying the lower portion of the receptacle, these flowers being similar in structure to those found in the "mamme." As before, the eggs develop into females and wingless males, the latter fertilising the former, which then escape and, in creeping from the opening, rub against the male flowers produced in the upper portion of the receptacle and thus become dusted with pollen. Loaded with pollen, the female wasps, escaping in July, enter the young "fichi," where they find the female flowers ready for pollination. In the "fichi," the female flowers have a long style, hence the insect cannot reach the ovule with its ovipositor — instead of laying its egg in the ovule of these flowers, the wasp simply smears the top of the style with pollen from the male flowers of the "profichi." The "fichi" thus produce normal seeds. During summer the insects wander in and out of the "fichi," but as the inflorescence grows in size the opening at the top becomes narrowed, and eventually the female wasps desert their summer home and enter the young "mamme," so that by September they are in their winter quarters once more. This brings the strange cycle of events round to the point from which we started (see Figure 329).

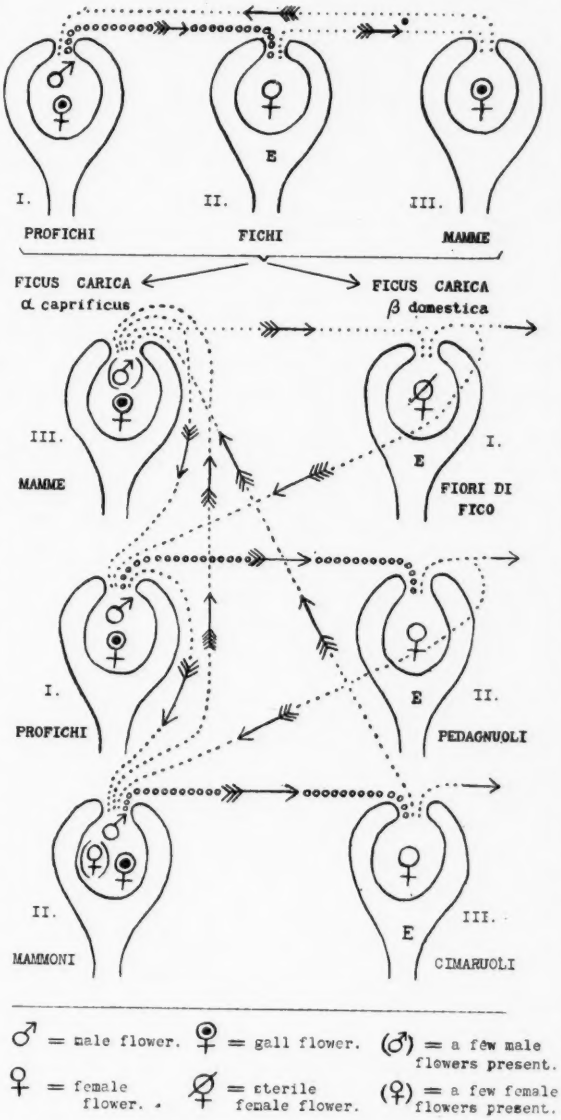

FIGURE 329.

Fertilisation of the Flowers of the Fig.

Diagram illustrating the relations between the Wild Fig and the varieties *caprificus* and *domestica*, also the migrations of the wasp (*Blastophaga grossorum*) in each of the three forms. The dotted lines indicate the ordinary paths taken by the wasp, the rows of small circles its paths when carrying pollen from one inflorescence to another. The edible inflorescences are marked E.

Evidently man—for it can hardly have come about in a natural way—has produced from the wild fig two forms which are propagated only by cuttings, a male and a female form, both showing an incomplete life-history as compared with the original wild form. This splitting up, so to speak, of the original wild form, has obvious advantages. The wild fig has only one edible crop, while the cultivated female (*domestica*) may bear three generations of edible inflorescences, giving ripe figs nearly all the year round. Moreover, the *domestica* form produces larger and sweeter fruits, which when ripe do not contain the unappetising black wasps found in the wild fig.

Ficus carica α caprificus bears typically three generations of inflorescences. The "profichi" (appearing in February or March, ripe in June and July) contain about two-thirds gall flowers and one-third male flowers. The "mammoni" (appearing in May, ripe in August or September) are similar, but contain fewer male flowers and sometimes have a few female flowers. The third generation consists of "mamme" (appearing in September, ripe in March or April), which contain gall flowers, with a very few males just below the opening, but no female flowers.

Neither of these generations in *caprificus* is edible, nor are any seeds produced. Of the three kinds, only the "profichi" come to full maturity; the other two kinds are produced in small numbers, and often fall off before reaching maturity, especially if they remain unvisited by the wasp. In fact, the *caprificus* form serves solely for the habitation of the wasp (which goes through its life-cycle here exactly as in the wild fig) and for the provision of pollen for the fertilisation of the flowers of the cultivated female fig. It is obvious that the *caprificus* form has arisen from the wild fig by suppression of the female flowers, which are in this form either

absent or reduced to a very small number, hence as a rule no seeds are produced. The *caprificus* has, so to speak, split away from the parent wild form, carrying with it the male character and the completeness of the adaptation to the wasp—in this form, and not in the cultivated female fig, we still have the so-called gall-flowers.

In the female fig (*Ficus carica β domestica*) there are either two or three generations, all of which are exclusively female or else sterile, and all edible; there are no male flowers or gall flowers. (1) The inflorescences of the first generation ("fiori di fico") rarely come to full maturity: most of them fall off in spring. They contain sterile female flowers, but these are not adapted to the wasp, since the style of the pistil is long and is closed up, hence if any of the insects stray in, they seek in vain to lay their eggs in these flowers. (2) In May or June appear the inflorescences of the second generation ("pedagnuoli"), and in most varieties these alone become fully ripe, maturing from August to October. These inflorescences contain normal female flowers with well-developed ovules, which are fertilised by pollen brought by the female wasp from the "profichi" inflorescences of the *caprificus*, these latter being mature at this time of year; hence the "pedagnuoli" produce ripe seeds. (3) The inflorescences of the third generation ("cimaruoli") hardly differ from the second, except that here the inflorescences are developed at the ends of the branches instead of lower down. They are produced in August and September, or even later, and in unfavourable seasons fall unripe from the tree, though in Italy these "winter-figs" are often produced in abundance. In general, the *domestica* form produces only one generation of fully-ripe fruits, usually the "pedagnuoli." In some varieties the earlier crop ("fiori di fico") ripens freely, and there are but few of the "pedagnuoli" matured in that case.

The *domestica* form has clearly arisen from the female generation ("fichi") of the wild fig, since it carries only the characters of this generation, and does not produce male flowers. The advantage of cultivating the *domestica* form, namely, the production of edible and insect-free fruits all the year round, is accompanied by the disadvantage that these fruits are relatively small. To obtain large fruits, which will remain on the tree until fully ripe, and which can be dried, fertilisation is necessary, and "caprification" is resorted to. This process, practised from ancient times, consists simply in placing branches of the wild fig or the *caprificus* (bearing "profichi") over the cultivated bushes—the wasp *Blastophaga* is sluggish of flight, hence the male inflorescences have to be brought close to the *domestica* plant in order that the wasp may carry pollen into the female inflorescences of the latter.

Besides the types *caprificus* and *domestica*, however, there are other forms of *Ficus carica* which may be regarded as reversions to the original wild fig. For instance, there is a transitional form between *Ficus carica* and *Ficus carica α caprificus*, in which the inflorescences of the first generation are of the "profichi" type, while those of the second generation have male, female and gall flowers. In another form, transitional between *Ficus carica* and *Ficus carica β domestica*, the inflorescences of the first generation have female flowers like those of the "fiori di fico," and an equal number of male flowers as in the "profichi," while those of the second generation are exclusively female.

NOTICES.

THE CLASSIFICATION OF SOILS.—Professor Elmerfitten, of Cornell University, gives in *Science* for May 3rd, a practical classification of soils. He first considers climate under the heading of "region" which is dependent upon temperature; while "section" is based on humidity. Under the heading of "province" mode of formation is discussed; the "group" occupies itself with the source of material; the subheadings of "series" are colour, organic matter, total plant-food content, while the "type" is determined by texture and structure. Altogether the article is a very suggestive one.

THE WORK OF THE IMPERIAL INSTITUTE.—*The Quarterly Bulletin* which records the progress of agriculture and industries in the colonies and India is now published by Mr. John Murray. The first number of Volume X is before us; it contains a number of important papers which are the results of investigations made at the Imperial Institute. They deal with such subjects as the rubber and timber resources of Uganda and cotton soils of Nyasaland, which are of technical interest, but there is much which will appeal to the general reader in the notices respecting economic products. Included are notes on the commercial uses of the cocoanut as well as the cultivation of hemp and of ginger. Allusion may also be made to the general notes, which will particularly appeal to botanists.

THE ALTERATION OF CHEQUES.—Mr. William Kinsley, who is an examiner and photographer of questioned documents, sends some interesting reprints of articles which he has written. One dealing with the alteration of cheques describes a case in which a twelve dollar draft had been so carefully altered that it required careful examination under the microscope to detect what had been done. The cheque had been perforated but the holes had been carefully filled up with paper pulp and new ones made, and the surface of the safety tint paper, after the erasure of "twelve," the old amount and the filling in of "twenty-two thousand" the new, had been restored by means of water-colour.

CHLORINE FOR THE TEREDO.—*The Scientific American* for May 4th, describes a means of killing the boring mollusc known as the Ship-worm or Teredo by means of breaking up sea water by electricity, so that chlorine gas is liberated in the neighbourhood of the submerged timber of wharfs. Electrodes are suspended in the water and the power plant is on a barge. The current is turned on for about an hour and the operation is timed so that the action of the tide will help rather than hinder the process of chlorination. The electrolytic treatment must, of course, be repeated from time to time.

THE SUBTLETY OF LIFE.

By MARGARET R. THOMSON.

It has long been a matter of common knowledge that certain organic poisons which gain an entrance, by some means or other, into the human body, have the effect, when once overcome by their victim, of rendering him invulnerable, or "immune," so far as that particular poison is concerned, usually for the rest of his lifetime. Familiar instances are the poisons produced by certain common infectious diseases, measles, whooping-cough, scarlet fever and the like, one attack of which, in the majority of cases, has the effect of protecting from subsequent attacks. It is on this fact of immunisation that vaccination as a preventive for smallpox is based, and the knowledge of it led Pasteur to his wonderful results in the treatment of rabies and in the "taming" of the deadly anthrax bacillus.

Equally familiar is the fact that there are poisons which render the individual increasingly tolerant of them if their use is persisted in. Thus, the confirmed opium-taker can imbibe or inject a dose which would certainly be fatal to a normal individual, and which would have been fatal to himself had he not accustomed himself to gradually increasing quantities. De Quincey, in his "Confessions," tells us that he gave to a wandering Malay who came to his door, a piece of opium large enough to kill six dragoons and their horses if they were not trained to it. The Malay received it with delight, broke it into three pieces, and immediately swallowed them all. De Quincey's own allowance at one period of his life was eight thousand drops of laudanum a day.

Within the last seven or eight years a new aspect of the effect of poisons has come into prominence. Certain poisons when introduced into the circulation increase, sometimes to an enormous extent, the susceptibility of the individual to the toxic action of that particular substance. This fact was apparently not unknown to some of the earlier physiologists, though it was not adequately described, and its importance was not recognised. For all practical purposes the phenomenon was discovered in 1902 by the eminent French physiologist, Professor Ch. Richet, and he it was who coined for it the name Anaphylaxis,—a companion word to prophylaxis or protection against disease.

In a recent number of a French journal, Professor Richet himself describes the way in which he was led to the discovery, and in the second edition of his book* summarises the facts that have been collected, and describes the experiments that have been made by himself and by other physiologists in various countries who have devoted their attention to the subject.

In the course of a series of experiments with the poison from the "stinging cells" in the tentacle of *Actinia*, one of the common sea-anemones, Professor Richet soaked portions of the tentacles in glycerine, and injected the solution of the poison obtained into the veins of a dog. He found to his great surprise that, while for a fresh subject a fairly large dose was required to cause death, a dog which had been treated with the poison about a month previously and had fully recovered his condition, quickly succumbed to a dose of about one-twentieth the original strength. That the poison was cumulative in its effect was the most obvious explanation, but the smallness of the dose, and the time which had elapsed since the previous injection, showed that this was improbable. The only possible conclusion from this and other experiments was, that the first injection brings about a particular physiological state which makes the individual more sensitive to subsequent injections.

A further step was taken in 1903, when M. Arthus showed that the same physiological state could be induced by a substance, such as blood-serum, which is not in itself toxic. A rabbit, which had been injected with a dose of horse-serum without showing any signs of disturbance, a month later succumbed at once on receiving an injection of one-twentieth the quantity of the same material.

Anaphylaxis is invariably specific—that is, an animal rendered sensitive by previous injection to one substance, is not affected as regards any other substance, not even a different kind of blood-serum. This has an interesting legal bearing. It supplies a new and conclusive method of determining the source of any given blood, *e.g.*, whether it is human or not. Thus if a set of guinea-pigs be treated with the serum of different forms, man, dog, horse, and so on—and after a month's interval be injected with a solution of the blood to be identified, the relevant guinea-pig will re-act at once, while the others will remain unaffected. Quaint, too, is the experiment of injecting an extract of the muscle of a human mummy into a set of guinea-pigs—for here, as elsewhere, the unfortunate guinea-pig has proved itself the best subject for experiment, its sensitiveness to a special substance being capable of being increased five-thousand times—and after an interval injecting other muscle-extracts. The animals re-acted to that of human muscle, and to that alone, "thus proving, if proof were needed, that the chemical constitution of the human body has not notably varied in the last three or four thousand years."

The medical aspects of anaphylaxis are discussed by Professor Richet in connection with the use of tuberculin; he regards the phenomenon as throwing light on its diagnostic value, and probably also on the occasional terrible accidents which for a time almost discredited it as a therapeutic agent. This latter point is still under investigation. The "serum disease," too, which sometimes follows the use of anti-toxin and inoculation for plague is

* "L'Anaphylaxie." Paris, 1912.

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probably to be explained in a similar way, and cases are described which show that a substance may be prophylactic against a particular disease, and yet anaphylactic against itself, so that anaphylaxis and immunity may be developed simultaneously. It is comforting to learn that physiologists have already devised an "anti-anaphylactic" method of procedure.

It has been shown that, while no crystallisable substance can produce anaphylaxis, almost any "colloid" or albuminoid substance (which is unable or hardly able to diffuse through organic membranes) may do so under certain conditions. Among these conditions are, that a certain time—an incubation period—must elapse between the doses, and that the substance, serum, egg, milk, muscle-extract, vegetable extract or whatever it be, must be introduced into the circulation. Alimentary anaphylaxis occurs very rarely, since it is the digested products of albuminoid substances, and not the substances themselves, that are absorbed into the blood. But the rare exceptional cases are of extraordinary interest, since they are the people, known to us all, to whom "eggs are poison," who cannot digest milk in any form, or who cannot eat a particular kind of shellfish without more or less severe symptoms, such as fever and nettlerash. Here, too, the phenomenon is absolutely specific, and Dr. Richet cites the case of a man who always showed violent symptoms after eating even a perfectly fresh shrimp, yet who could indulge freely in lobster without inconvenience!

There is also a "passive" anaphylaxis. If the blood of an animal anaphylactised in regard to a particular substance be injected into another animal, that also is rendered anaphylactic to the same substance. Interesting, too, is the fact that anaphylaxis in a mother, acquired either before or after conception, may be congenital in the offspring, but the condition is not usually of long duration. In guinea pigs it was noted on the forty-fourth day, but had disappeared by the seventieth day.

Professor Richet's discussion, based on his own experiments, of the precise way in which anaphylaxis is brought about, is too technical to be of general interest. Suffice it to say that he regards the first introduction of the albuminoid as modifying the blood by producing in it, during the incubation period, a chemical substance, which is not in itself toxic, but which is capable of becoming immediately and violently so in the presence of the original albuminoid. So numerous are the substances which may bring about modification, either in the direction of anaphylactisation or immunisation, that each individual of a species must differ from every other in chemical constitution; and the vague "idiosyncrasy" of the past must give place to a more definite conception of a chemical personality which embodies the results of the individual's physiological history, just as his psychological personality registers his mental experience.

But notwithstanding the differences between the individual members of a species, there is a typical specific chemical constitution which cannot be widely departed from if the species is to persist. And it is in this fact that Professor Richet finds the key to the apparent contradiction between anaphylaxis and the general biological law, that every living organism is in an optimum state of protection. "I am more and more convinced," he writes, "that every detail of the organism has a protective rôle, and is useful and even necessary to life, and that, therefore, a great general biological function like anaphylaxis must play an essential part in the defence of organisms. So that anaphylaxis appears to us an efficacious and energetic method of maintaining the chemical stability of our bodies by provoking an immediate and violent reactional response to the introduction of any substance which might change it. This is not the defence of the individual; it is the defence of the species at the cost of the individual."

ENGLISH LAKE DWELLINGS.

IN 1880 I wrote a short note on the Swiss chalets as being the descendants of the old lake dwellings (*Nature*, October 7th). A subsequent writer drew attention to the fact that someone else had previously suggested the same thing. I now wish to draw attention to the fact that we seem to have had something of the same kind in England. In the "Life and Letters of Professor A. Sedgwick (Vol. I, p. 13–15) there will be found illustrations of houses in his native village of Dent which stands in a valley, presumably once a lake. The dale of Dent is situated in the westernmost extremity of Yorkshire, in which the River Dee now flows westerly into the Lune. The entrance to the long valley at the west end is represented on the map as five-eighths of a mile, or about eleven hundred yards.

The chief feature, both of the Swiss chalets and the houses in Dent, is to have an outside staircase or steps to the rooms above, which were surrounded by a "gallery," as Sedgwick calls it; but when he wrote they were fast disappearing. The lower, or "ground floor," is mostly used now for fodder, for the cow, in Switzerland; but is built in, in the houses in Dent. The left hand figure, however, on page 13, shows one still open. The gallery is seen on the left hand side of page 13. These two illustrations were made in 1820.

It would thus seem that the old Dent houses really carried on the tradition of a flat above the water, with the entrance by means of a staircase outside, down to the water.

A curious hint (as it may perhaps be called) is seen in the Babylonian cosmogony discovered by Mr. G. Smith in 1872, which seems to have been—or some other more or less like it—the source of Genesis i. One of the tablets says:—

"(Anu) made suitable the mansions of the (seven) Great Gods.
The stars he placed in them.
. . . . . .
The mansion of Bel and Hea he established along with himself.
The bolts he strengthened on the left hand and on the right.
In its centre also he made a staircase."

The house is thus built *over* the "Water *above* the firmament." Since the air or "firmament divided the waters (clouds) from the waters (ocean)." (Genesis i, 6).

The house, therefore, with its staircase, would seem to have been built after the same fashion of an early lake dwelling somewhere near the Persian Gulf.

GEORGE HENSLOW.

THE DISCAL FLORETS OF *SENECIO JACOBOEA*.

By SIR W. W. STRICKLAND, B.A.

A GOOD many years ago, I began a series of observations on the phyllotaxis of composite flowers, in the North of Italy. By a curious coincidence, Professor Ludwig of Gratz was making very similar observations, which he published about the year 1894. But while he confined himself to the ray florets I have more or less completely solved the problem of the discal florets, and the solution, if my observations are ever published, will completely transform our ideas of the evolution of organic form.

What has been established with absolute certainty about the rayed florets of the Compositae is that, in the vast majority of cases, where they do not exceed fifty-five in number—beyond which statistics have not yet probed, they follow the law of phyllotaxis. In other words, in the vast majority of cases the rayed florets are three, five, eight, thirteen, twenty-one, thirty-four, and perhaps fifty-five in number. Eight and thirteen are also doubled and in the small wild calendula we have a maximum at twenty-six, with the principal maximum at sixteen, and in the common wild blue chicory (*Intyba chicorea*) at sixteen with a large sub-maximum at fifteen. A scarce large flowering Achillea found near Sonnico below Edolo—the specific name of which I forget, and, not having my notes with me, consequently cannot give—has also sixteen rays, and doubtless there are many other instances. With respect to the number twenty-six, I cannot as yet give an explanation, but as regards sixteen there is a good deal to be said.

Intyba chicorea, as observed, gives a small maximum at sixteen, very nearly reached by the sub-maximum at fifteen, after which there is a large drop, and the reason of it is apparent to the naked eye. Naturally when the seeds set, the fruits retain the position of the florets. In these flowers of *Intyba chicorea*, the seeds set in the form of a more or less pentagonal tessellated pavement, and in the case of the seed-head with the sixteen constituent parts, the arrangement was also obvious to the naked eye. A ring of five fruits was surrounded by a ring of eleven. I then analysed geometrically the seed-heads of *Intyba chicorea* for all numbers from thirteen to twenty-one, and it was demonstrated, with mathematical certainty, that *in all cases* they represented *whole or partial* concentric rings of circles beginning with a ring of five. Thirteen represents a ring of five surrounded by eight out of the eleven of the second ring, sixteen represents five surrounded by the complete second ring of eleven, twenty-one represents sixteen with five out of the seventeen of the third or next outer ring, and so of all the rest. I need not, perhaps, remark that each concentric ring increases by six circles composing it so that three complete rings of circles sum $5+11+17=33$.

As I have said, the reason why in *Intyba chicorea* we have a maximum of sixteen florets and a sub-maximum of fifteen is obvious at once, because sixteen is the sum of the first and second rings of two concentric rings of circles beginning with a ring of five. Another botanical fact in connection with these discoveries clenches the argument and throws a flood of light upon the evolution of form. An allied species to *Intyba chicorea*, but rarer and growing in drier and stonier habitats, is *Scariola*. It is yellow flowering, often found by rocky beds of torrents dry in summer. Its chief habitat is the lower part of the Val de Sole, a stony valley with vast moraines from the glacial epoch, in that part of the Austrian Tyrol which ought to belong to Italy. Here the flower heads of *Scariola* are, I may say, invariably composed of eleven florets. Although eleven is practically the invariable number, last autumn I found a few plants of a dwarfed *Scariola*, growing at the foot of a high stone wall, flanking the exposed and dusty road from Salô to Maderno on the Lago di Garda. The spot was dry and stony, without grass and with hardly anything else but the *Scariola* growing upon it. A great many of the flower-heads of these plants were composed of only ten florets. Why has *Scariola* eleven florets? The reason seems to me clear, viz., that when *Intyba chicorea*, which is found on grassy roadsides, straggled on to stony ground, all its parts shrunk, the florets turned yellow, the stalks grew thinner and lankier and the inner five florets were squeezed out of existence, and only the eleven outer circlet of florets remained. Further contraction caused a re-arrangement visible to the naked eye: three of the eleven forming an inner circle of three, surrounded by a ring of eight: which corresponds to two concentric rings of circles, beginning with a ring of three with one of the outer nine missing. That this is the true explanation can be inferred from other similar facts. *Prenanthe muralis* is a form of hawkweed though put in another genus, which, as the name implies, is attached to a stony habitat, and has its florets reduced invariably to five in number. A similar *Prenanthe*, but rarer and with purple flower heads, haunts similar localities, and its flower-heads also consist invariably of only five florets. It is abundant about Torno on the Lake of Como, and is remarkable for the fact that it is practically impossible to dry it and prevent its florets from turning to fruits in the process. Something of the same kind occurs in the subject of the present essay. When flowers belonging to plants growing on stony ground are analysed, it is found that the ligules of the rayed florets are longer than those of plants growing on relatively rich soil, also the discal florets are much less numerous. Thus in the former case the number of discal florets ranges

XUM

from fifty to a hundred and rarely exceeds the latter number, whereas in the latter, the number of discal florets ranges from one hundred to one hundred and fifty-five, and rarely sinks below one hundred. Moreover, the rayed florets are broader and shorter. For some reason not explained many composite flowers at a high level tend to develop their rayed florets.

All over the North of Italy the common ox-eye daisy has an enormous majority of flowers with twenty-one rays. In the same localities in the autumn, towards the termination of the flowering season, two sub-maxima occur, consisting of comparatively dwarfed flower-heads on *non-branching* plants, in which the great majority of rayed florets are respectively eight and thirteen in number.

On the other hand a little after the beginning of the flowering season, at high levels, on garden soil, facing south, plants can be found with a large majority of flower heads, with rayed florets thirty-four in number, which is the next phyllotaxis number above twenty-one. I demonstrated this with the utmost certainty, in the case of ox-eye daisy growing in high level localities, near Rovena above Cernobbio, Lago di Como. On Monte Grigna, the Eastern or Lecco branch of the lake, occurs at still high levels a rare and gigantic species called, if I mistake not, *Chrysanthemum imbricatum*, which doubtless has thirty-four and perhaps fifty-five elongated rayed flowers, but I have not as yet obtained specimens. Another instance, however, of the development of the ray florets is the wild Arnica, which occurs at comparatively high levels, not as a rule below four thousand feet, on pastures (above Brunate, Lago di Como) or on marshy meadows (Tonale Pass, Val Camonica). In valleys by slow-running rivers and in other similar localities just the opposite occurs. The rayed florets become broad, short and few in number or disappear altogether, while the number of the discal florets increases. A common instance of this is *Gallinsoga canadensis*, found all over the North of Italy, and also in the South of England, where it was introduced about thirty years ago, and rapidly spread down the Thames Valley from Kew to Oxford. In this plant the rayed florets are reduced to invariably five in number (broad and scale-like) having been crowded out by the discal florets which form a thick convex topknot. In the common tansy (*Tanacetum vulgare*) which haunts the banks of low-level or comparatively low-level rivers, the rayed florets have disappeared altogether, and the discal ones become numerous and close packed. *Tanacetum vulgare* is never found with its distant relation the romantic edelweiss in its ideal sites of snow and ice. A perhaps still more remarkable instance occurs in Australia and New Zealand. In tropical and hot sub-tropical countries composites are not as a rule plentiful: thus in New Zealand, *i.e.*, in the North Island and in Eastern Australia (for strange to say in hot Western Australia there is a wonderful development of novel forms of composites) there is only one that strikes the eye, a small creeping plant, growing in moist spots, and lush water-meadows, with flower buttons similar to those of the tansy, but smaller and more hygrophanous. On the other hand in the almost sub-Arctic and rugged Stewart Island, there are several composite shrubs and small trees, the flowers of which abound in rayed florets.

To sum up the results so far as indicated by the above remarks. In all composite flowers with rays, the number of which does not greatly exceed thirty-four, the vast majority of flowers have two (rare), three, five, eight, thirteen, twenty-one and thirty-four rays, or, in some few cases, double eight and double thirteen *i.e.*, sixteen or twenty-six. Again, in a few plants of which the florets are all liguled, and not differentiated into rayed and discal ones, *e.g.*, in chicories and prenanthes, the flowers represent two rings of the concentric ring system, beginning with a ring of five, or more rarely one of the rings (five or eleven) or again one ring (five) and part of the second or two rings (five and eleven) and part of the third. As regards the discal florets of composite flowers differentiated into disc and corona, nothing has so far been said.

Some years ago I attempted to estimate, at Cernobbio, the number of discal florets of the small, late autumn form of the ox-eye daisy with thirteen rays, by counting the number of discal florets in a cross section of the disc or eye, but soon found that to estimate the number of discal florets in a closely-packed disc like that of the ox-eye daisy was an impossibility, or, at any rate, a perfectly futile waste of time; because, owing to crowding, numbers of florets were reduced to pin points, or crowded out of existence altogether, so that an estimate of what remained could only yield statistics on which no sound reasoning could be based. I therefore turned my attention to the small wild calendula, abundant in most coast regions all down the Italian Peninsula. The observations were made at Taormina, on what may almost be called a gigantic scale, and resulted in the demonstration of a law so simple and yet so wonderful, that even now, although the evidence is overwhelming, I still regard it with a modicum of scepticism. I shall reserve the enunciation of it until the whole voluminous series of observations are published, when, if they ever are published, the law in question will excite wonder, astonishment and delight in everyone not dead to these sentiments and emotions. For the present I confine myself to a general statement that in the calendulas, as in the chicories and prenanthes, the discal florets are arranged in concentric rings of florets in a majority of the flower heads.

The other day, some plants of *Senecio jacoboea* (common ragwort) reminded me that this is one of the very few composites the flower-heads of which have almost invariably thirteen rays, more exactly ninety-eight per cent. and a fraction, so that this plant may claim a certain community of ideas with one of the pseudo-cycads, the flower of which, a thirteen-rayed star, was figured in "KNOWLEDGE" (May, 1910, page 174), and of interest as supposed to be

one of the ancestors of our buttercups and daisies and other phanerogams, and it occurred to me that it might be worth while to see if any conclusions could be drawn from counting the discal florets. In picking the flowers to pieces it was observed that there were some dwarfed and aborted discal florets, but not nearly so many as in the case of the thirteen-rayed ox-eye daisy, no doubt because the number of discal florets (range about fifty to one hundred and fifty-five) was much smaller and consequently they were less crowded. This would, however, mean a certain negative error; again, owing to the greater number of the florets, the errors in counting would also be greater than in the case of the calendulas, and such errors are generally negative ones. A floret is passed over uncounted. It is to be observed, however, that these errors do not tend to false conclusions, but only to diminish the evidence for a maximum, if one exist; for example, suppose a plant like *Senecio jacoboea* has generally thirteen rays: in counting the rays we are much more likely to make a mistake in the case of a thirteen-rayed flower, than in a twelve or fourteen-rayed one, because there are hardly any of the latter, and the same is true to a less extent in the case of flower-heads with a smaller maximum or maxima. On the other hand, if there be no sensible maxima, and there is pretty nearly the same number of flower-heads with one number of discal florets as with another within the whole range, we are as likely to count one number wrong as another, so that the errors will not build up a fictitious maximum, but, if we go on long enough, more or less completely cancel one another out.

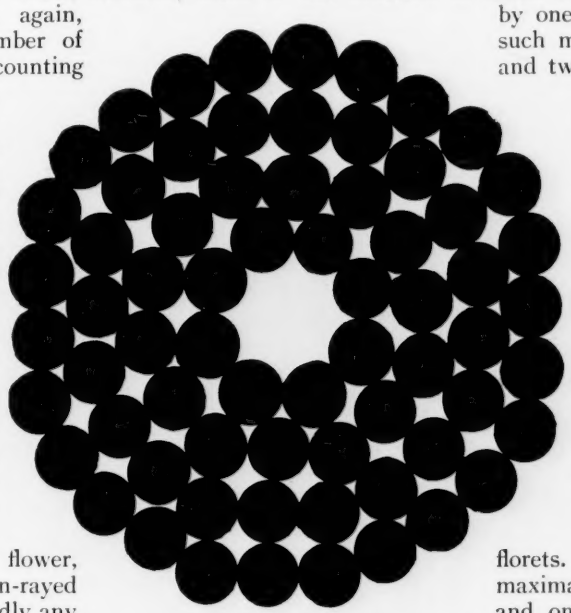


FIGURE 330.
The primitive form of *Senecio* as deduced from *Senecio jacoboea*.

The discal florets of three hundred flower heads were counted. The subjoined diagram summarizes the result, which, considering the small number of flower-heads counted and the sources of error above alluded to, is sufficiently striking and complete. Three possibilities occur to one.

1.—The discal florets may represent phyllotaxis numbers or their doubles.

2.—Concentric rings and their doubles.

3.—Or they may be multiples of five.

In one hundred and five consecutive numbers, the number of multiples of five to the whole number is roughly six to twenty-one, or about eighty-eight to three hundred; and it was found that in the countings the number of multiples of five was considerably below this average that chance would have given, so that the discal florets tend not to be produced in groups or multiples of five.

We have, therefore, only to consider phyllotaxis numbers, concentric ring numbers and their doubles.

Referring to the diagram we see that there is a shadowy, very shadowy, tendency for maxima to coincide with numbers representing concentric rings of circles. It is possible that the maxima at one less than these numbers, of which there are four, may really belong to these numbers, errors of counting or the abortion of discal florets having reduced them by one. The most important of such maxima is at one hundred and twenty representing six concentric rings of florets beginning with a ring of five.

The three really important maxima are, however, at eighty-nine, one hundred and ten, and one hundred and twelve. The eighty-nine maximum is explained at once, eighty-nine being the next phyllotaxis number above fifty-five. The absence of a maximum at fifty-five is due to the fact that there are hardly any flower-heads of *Senecio jacoboea* with less than sixty discal florets. How are the two principal maxima at one hundred and ten and one hundred and twelve to be explained? Evidently they are due to the doubling of the two numbers, fifty-five the phyllotaxis number, and fifty-six which represents four concentric rings of the ring system beginning with a ring of five (5, 11, 17, 23=56). I am afraid those who have no practical knowledge of the working of the phyllotaxis and concentric circle law in the evolution of composite flowers will hesitate to accept the inference, which, however, I believe to be valid, viz., that *Senecio jacoboea* has been developed from a more primitive form, which flourished on poor or rocky soil, by straggling on to a more fertile habitat. All organic life develops by dichotomy (cell division) giving numbers 2^1, 2^2, 2^3—2^n. At the beginning of this series eight and sixteen gave a ring of three surrounded by a ring of five (imperfect five instead of nine, but corresponding to vast numbers of phanerogam flowers) and the perfect system of five surrounded by a ring of eleven, giving 2^4 or 16, and considering the maximum at one hundred and twenty, six concentric rings beginning with one of five, it is not wonderful if the primitive form had a closely similar arrangement, viz., four concentric rings beginning with a ring of five. If to the phyllotaxis number, fifty-five, we add the other, thirteen, the number of the rayed florets, we get the number

sixty-eight, which corresponds to four concentric rings of circles of the ring system beginning with a ring of eight (8, 14, 20, 26=68) (see Figure 329). The outermost ring contains just twenty-six florets so that every other floret would be a rayed one. In the analysis of the calendula there were reasons for believing that sometimes a certain number of the discal florets was disposed symmetrically in the outermost, that is, the ring of rayed florets. Let us suppose the cell from which the composite flower-head sprung submitted to three cell divisions and we get eight (2^3) cells and if these arranged themselves in a ring of eight they would form the basis of the above-mentioned system in the ancestral *Senecio*. This may partly explain the evolution of the phyllotaxis number thirteen, or in certain cases but only partially. The system gives an ***approximately*** regular thirteen-rayed star.

A word of warning is necessary regarding the diagrammatic mode of representing statistics now so much in vogue, at least as regards the present diagram. The two chief maxima appear sufficiently striking, but making all due allowance for negative errors and aborted florets, they only represent maxima of about five per cent. We need not suppose, therefore, that the more primitive type had all its flower heads with fifty-five or fifty-six discal florets; twenty-five per cent. of each would be quite enough to account for the maxima in the present instance. It so happens that the next lower phyllotaxis number for three concentric rings of circles beginning with a ring of five (thirty-three), and the next lower phyllotaxis number thirty-four, also only differ by unity, in this case the phyllotaxis number being the greater.

The next phyllotaxis number twenty-one has no number of the five ring systems at all near it, but the thirteen has sixteen or two concentric rings of circles, beginning with a ring of five corresponding to two maxima in *Intyba chicorea*. There is another very remarkable case where the phyllotaxis number thirteen occurs invariably in certain of the animal and not vegetable kingdom.

Leaving this more or less speculative field, the fact remains demonstrated that the four principal maxima of the discal rays of *Senecio jacoboea* represent:—

(1) The phyllotaxis number 89.
(2) The phyllotaxis number 55 doubled=110.
(3) The sum of four concentric rings beginning with a ring of 5 doubled=112, and
(4) The sum of five concentric rings beginning with a ring of 5=120.

Those who have hitherto believed that the evolution of symmetrical form can be explained by "protection" and "survival of the fittest" in its ordinary sense, at the conclusion of this essay may perhaps be less confident in their assertions. The fact is that the fatal gift of symmetry exposes the possessor of it to a host of enemies. The naked eye can detect almost microscopically small snail shells on account of their symmetry, and to protect them "protection" and "natural selection" so far from evolving symmetry, have to evolve all sorts of devices to mask it, carried to extreme lengths in certain sea horses and stick-insects. "Protection" and "natural selection" are not invoked to explain the symmetry of crystals, and there is not a shred of evidence to prove that they have any more to do with the evolution of organic than with the evolution of crystalline symmetry. I may conclude by saying that the law of the exposure to risk from symmetry is universal, and is found in the moral as well as the organic world.

Note.—Since writing the above, I took a walk to a spot (above Cimburg) about one thousand metres above sea level. Here, on rocky ground, was growing a somewhat viscid plant something between a groundsel and a ragwort. I believe it is classed as a ragwort. I brought home a few heads which gave the following result:—

Rays.	Discal Florets.	
13	41	= 55 or 4 rings of 5-ring system − 1 the phyllotaxis number.
13	42	
13	42	
13	43	
13	33	*i.e.*, 13 and 3 rings of the 5-ring system.
13	39	*i.e.*, 13 and 3 rings of the 7-ring system.
13	36	
10	31	

VENUS: THE PLANET OF MYSTERY

By FRANK C. DENNETT.

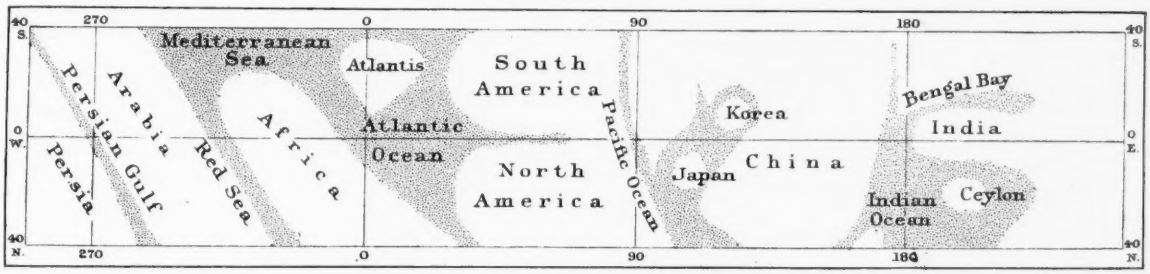
NO other planet shines with such a brilliant light as Venus, either as an evening, or as a morning star; so brilliant even that it will throw a very evident shadow. Although a little less in size than the Earth, when nearest to us, it attains an apparent diameter greater than that of any other planet. Notwithstanding its closeness, an air of mystery has seemed to hang over its study, making the work of different observers yield most contradictory results.

Its supposed satellite was observed first by the elder Cassini, who wrote thus: "A.D. 1686, August 28th, at fifteen minutes after four in the morning, looking at Venus with a telescope of thirty-four feet, I saw at the distance of one-third of her diameter eastward a luminous appearance of a shape not well defined, that seemed to have the same phase with Venus, which was then gibbous on the western side. The diameter of this phenomenon was nearly equal to a fourth part of the diameter of Venus. I observed it attentively for a quarter of an hour, and having left off looking at it for four or five minutes I saw it no more; but daylight was then advanced. I had seen a like phenomenon which resembled the phase of Venus, January 25th, A.D., 1672, from fifty-two minutes after six in the morning to two minutes after seven, when the brightness of the twilight made it disappear. Venus was then horned; and this phenomenon, the diameter whereof was nearly a fourth part of the diameter of Venus, was of the same shape. It was distant from the southern horn of Venus a diameter of the planet on the western side." The next observations were made by the celebrated reflector-maker, James Short, on the morning of October 23rd, 1740, using a 16·5 inch reflector, magnifying between fifty and sixty, when he measured a star 10′ distant from the planet. Using powers of two hundred and forty and one hundred and forty, the little

object was found to be rather less than one-third of the planet's diameter in size, and presenting a similar phase. He saw it several times during about an hour, but never afterwards found it. On four evenings during May, 1761, M. Montaigne, of Limoges, saw what seemed to be the satellite, always presenting the same phase as the planet, and one quarter of its diameter, but in altered positions. During March, 1764, Rödkier, Horrebow and others with a refractor at Copenhagen, and Montbarron at Auxerre with a reflector repeatedly observed this object. Subsequently, Lambert collected the whole of the observations and calculated its orbit, publishing the calculations in Bode's *Jharbuch* for 1777. To allow the supposed moon, however, to complete its circuit in $11^d\ 5^h\ 13^m$ at a distance of two hundred and fifty-five thousand miles, as calculated, the mass or weight of Venus would have need to be increased tenfold. Doubtless the supposed satellite was a "ghost" in the eyepiece, yet it must be admitted that Short's use of at least three eyepieces is very puzzling. Since 1764, however, the "ghost" seems to have made no further apparitions.

Perhaps the greatest paradox has been the rotation period, period was twenty-three days. Other observers, such as Terby, Perrotin, and Lowell confirmed Schiaparelli, and the general conclusion of such has been that the rotation period is probably identical with the period, in other words is two hundred and twenty-five days. Niensten and Stuyvaert, at Brussels, observing in 1881 and 1890, supported the short rotation period, as also did Trouvelot. Brenner gave the period as $23^h\ 57^m\ 36^s$, and latterly McHarg, from his own observations and all available material, finds the period to be $23^h\ 28^m\ 13^s{\cdot}595$, and constructs a map of its surface, which we reproduce. On the other hand, Mascari came to the conclusion that the period was slow.

Long ago De Vico noticed that the observers who were best able to see the markings on Venus were those who had the greatest difficulty in seeing minute companions to bright stars. The writer sees the markings with ease in a good air, yet at the same time the details lack the sharpness of many of the Martian markings. At the same time the motion from rotation could be watched in half-an-hour as readily as could that of Mars. The only conclusion that can be arrived at is that some observers do see the surface of the planet modified by



From a drawing *by J. McHarg, M.A.*

FIGURE 331. Map of Venus.

some observers finding it to be less than a day, whilst others have thought it was nearly or quite equal to Venus' orbital period of two hundred and twenty-five days. The real trouble seems to be due to the different sensitiveness of different eyes to certain light rays. Cassini, who appears to have paid special attention to bright spots, wrote: "The space on these" (Mars and Jupiter) "I could attentively observe for a whole night, when the planets were in opposition to the Sun; I could see them return to the same situation, and consider their motion during some hours, and judge whether they were the same spots or not, and what time they took in turning round: but it was not the same with the spots of Venus, for they can be observed only for so short a time, that it is much more difficult to know with certainty when they return into the same situation. I can, however, supposing that the bright spot which I observed on Venus and particularly this year was the same, say that she finishes her motion, whether of rotation or libration, in less than a day; so that, in twenty-three days nearly, the spot comes into the same situation on nearly the same hour of the day, though not without some irregularity." In 1667, on April 20th, he observed the motion of the bright spot during the period of his observation. The period according to Cassini, the younger, was $23^h\ 21^m$. In 1726–27 Bianchini with a two and a half-inch refractor, no less than sixty-six feet in length, came to the conclusion that the rotation occupied $24^d\ 8^h$, the error doubtless arising from his small means and the short time he could follow the object of his study. Schroeter, from eight observations of a fixed point on the surface, obtained a rotation period of $23^h\ 21^m\ 7{\cdot}98^s$. At the Vatican Observatory, Rome, De Vico and his helpers, 1839–41, found a period of $23^h\ 21^m\ 22^s$, a result obtained after an enormous amount of work. In 1890, Schiaparelli, after discussing all available material, came to the conclusion that rotation was slow, not less than six or more than nine months. He seems to have in some way misread Cassini, and supposed that his an atmospheric envelope, whilst others fail altogether. Can this be due to a form of colour blindness? the markings being of a tint to which some eyes are susceptible and others not. This fact, if accepted, would explain a good many of the mysteries of observational astronomy. Mascari's observations can possibly be explained in another way. If the little map be examined it will be noted that large dark markings are situated one hundred and eighty degrees apart, whilst midway between them on either side only very delicate details occur. Mascari seems to have thought the dark markings were both the same, and when the intermediate portions were presented he was unable to see anything.

Perhaps the greatest mystery is yielded by the spectroscope. In 1900, Belopolsky, at Moscow, found the lines were curved at the limb to an extent only to be explained by a quick rotation. This seemed to give a definite answer. However, in 1903 the spectroscope at Flagstaff Observatory, in the hands of Slipher, gave absolutely contradictory results. The news was given in the number of *The Observatory* for August, 1911, that the Russian observer has continued his researches, and that the results of 1903, 1908, and 1911 confirm those previously obtained. Moreover, the instrument has been verified on Mars, the rate of whose rotation is known. "He found for its equatorial velocity 0·354 kilometres per second, instead of 0·254 kilometres. The value found for Venus, 0·38 kilometres, corresponds to a period of rotation of 1·44 days."

There is another mystery respecting Venus, to which only allusion must be made—the visibility of its unilluminated surface near inferior conjunction. Some observers have recorded that the disc appears dark on a brighter background. Others, however, maintain that it appears brighter than the background upon which it is seen. The former can easily be explained, but it is strange how a dark body can appear brighter than a somewhat illuminated background. Even an explanation of auroral lighting is very inadequate when we consider the brightness of the background upon which it is seen.

XUM

THE KNOWLEDGE OF THE MAKERS OF SCIENTIFIC INSTRUMENTS IN THE SEVENTEENTH AND EIGHTEENTH CENTURIES: THEIR TRADE-CARDS AND OTHER RARIORA.

By A. M. BROADLEY.

Author of "The Royal Miracle."

ALTHOUGH the Guilds of the Clockmakers and the Spectaclemakers occupy a prominent position amongst the ancient Livery Companies of the City of London, the manufacturers of scientific instruments of various descriptions not coming within these two categories do not appear to have ever obtained a charter or sought the benefits and privileges of incorporation. This is the more curious and inexplicable as the "art and misterie" they follow has flourished for considerably more than three centuries, and in many cases they can boast of a continuity of business association rarely to be met with in other callings. In his "History of the Livery Companies of the City of London" Mr. W. Carew Hazlitt mentions the fact that in 1672 the incorporated or voluntary associations of the Cartwrights, Boxmakers, *and Instrument-makers* were mentioned as branches of the Carpenters; but one would imagine that the artificers thus referred to were engaged in the production of saws and chisels rather than in that of the necessary aids to mathematics or navigation. It is curious, however, to note that the germ of the Clockmakers' Guild is to be found in the muniments of the Blacksmiths, who, both here and on the Continent, as Mr. Hazlitt points out, "once and long occupied a station importantly differing from the workmen of the same denomination familiar to ourselves and our immediate predecessors." It may also have been thus with the Carpenters. When the existing Clockmakers' Company was constituted in 1631, scientific clockmaking had already made very considerable progress, and the Coffin-Clock was an established fact of some standing. The makers of primitive timepieces were at first intimately connected with both the Blacksmiths and the Woodmongers, and it was a difference with the former which led to the petition for separate incorporation in 1629–30. The charter of the Clockmakers bears the date of August 22nd, 1631, and its initial letters contain a well-executed miniature of King Charles I enthroned. The Company can count on its roll of members nearly all the most distinguished masters of the art: from David Ramsey, the first Master, down to William James Frodsham and other well-known clockmakers. One of the most eminent makers of clocks of the early seventeenth century was Edward East, and it is said that the granter of the charter, when Prince, used to play tennis for an *Edwardus East*, or, in other words, a watch of East's manufacture. Thomas Tompion and George Graham were equally famous in their day, the latter being a member of the Royal Society. They were both buried in Westminster Abbey, and Dean Stanley was instrumental in recovering and replacing the slab recording the fact, which had been removed. The

FIGURE 332. John Dollond.
Engraved by A. Posselwhite, from an original picture in the Royal Observatory, Greenwich.

FIGURE 333.
The Copley Gold Medal of the Royal Society, awarded to John Dollond in the year 1758.

Clockmakers possess by purchase, gift or bequest, a very valuable collection of clocks, watches and other objects relating to their calling. A coat of arms was granted them by Clarencieux in 1671, with the motto *Tempus Rerum Imperator*. The crest of the Clockmakers figures on several of the trade cards of the makers of scientific instruments. One of the supporters originally assigned to the Clockmakers was the "Wild Man," whose identity has been the object of much archaeological research. In the coat now in use he is replaced by a winged figure of Time.

The Spectaclemakers obtained the benefits of a charter of incorporation two years before the Clockmakers. The great majority of those who now belong to it have no actual concern in the calling which it is supposed to protect and foster. The present writer lately acquired from M. Godefroy Mayer, of Paris, a collection of portraits illustrating the evolution of spectacles from the earliest time. The original armorial bearings of the Spectaclemakers have been modernised, but the old motto, "A blessing to the aged," has been retained. By an act of the Common Council, passed on July 1st, 1658, all makers of spectacles were required to take up the freedom. Information as to the early history of this interesting guild, which owes a great deal to the support of Lord Burnham and his son, Mr. Harry Lawson, is almost wholly wanting. In 1644, fifteen years after the incorporation of the Spectaclemakers' Company, two curious little books were published concerning the art and mystery it protected. The first was entitled "A New Invention; or a paire of Cristall Spectacles. By helpe whereof may be read so small print that what twenty sheets of paper will hardly contain shall be discovered in one." By way of frontispiece we have an engraving of a multiplying glass or lens with an eye in the centre. The companion volume is described as "The Second Part of the Spectacles."

Mr Summers
London 16 May 1763
Bought of P. Dollond
Optician to His Majesty,
and to His Royal Highness the Duke of York,
near Exeter Exchange in the Strand
A 5 foot Achromatic Telescope on a Pedestal Stand 5 15 6
A Camera Obscura 3 13 6
A Sciopticon 0 10 6
June 23 A complete Microscopic Apparatus 9 9 —
A Set Compass Box with a Sun Dial 0 12 —
£ 20 0 6
Rec'd 3 Feb'y 1764 the Contents in full
Peter & P. Dollond

FIGURE 334.
One of Dollond's Invoices made out in the year 1763.

It is obvious, however, that this handicraft was extensively practised long before 1629. Mr. Hazlitt points out that:—"In Newbery's 'Dives Pragmaticus,' 1563, we find the Spectaclemaker mentioned among

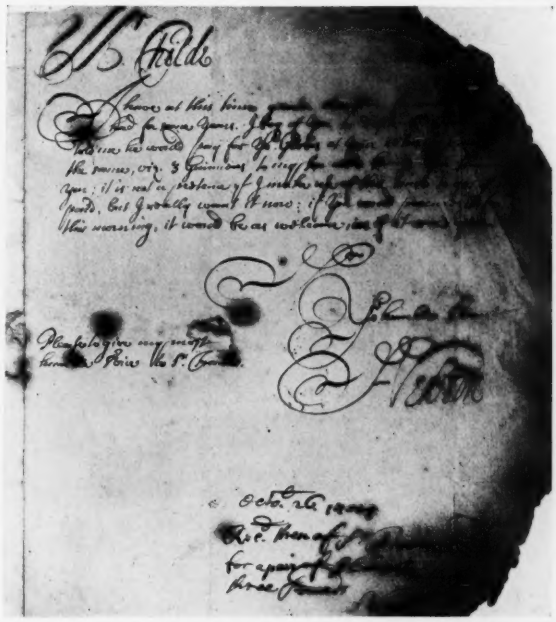


FIGURE 335.
Letter of John Newton to Mr. Thomas Child, dated October 26th, 1704, asking him to desire Sir Francis Child to pay for certain globes.

the other traders, who would be obliged to resort to a supposed universal provider of wares:—

'As Spectaclemakers, for dim sighted eyes.'

And further on he speaks of 'spectacles made of fine Burral [crystal] glass.' In the biography of Carlo Zeno, an illustrious Venetian statesman and hero, who died at the age of 84 in 1418, we are expressly informed that he never wore artificial aids to his sight, which is another way of saying that such appliances were then in ordinary use in Italy."

The history of the historic firm of Newton & Company, "makers of globes and all sorts of mathematical instruments," which has only just removed from its old home in Fleet Street, to 72, Wigmore Street, and 37, King Street, Covent Garden, dates from the early part of the eighteenth century. The fine trade card of Nathaniel Hill now reproduced (see Figure 336) is in the collection of the present writer. A copy of this card in possession of the firm bears the following endorsement on its frame:—

This was given to Frederic Newton, Esq., by William Newton, Esq., of 66, Chancery Lane, who received it from his Father, John Newton, who was in the business with

Nathaniel Hill at 128, Chancery Lane, just by Fleet St. corner. Nathaniel Hill was related (a nephew or son-in-law) to the Newtons, whom he succeeded in the business.

The Newtons of Newton and Company, trace descent from one Isaac Newton, who flourished in Lincolnshire, in the reign of Henry VII. It was one of his descendants, John Newton, born in 1649, and a cousin of Sir Isaac Newton (1642 — 1727), who founded the business which in the middle of the eighteenth century and later was carried on by Nathaniel Hill, at 128, Chancery Lane, close to the Fleet Street corner. The John Newton born in 1649 had a son, born in 1678. Nathaniel Hill took into partnership one of the Newton descendants, who also bore the same name. The John Newton born in 1759, and who lived till 1844, gave the copy of the trade card possessed by the firm to his son William, who was born in 1786. The copy of the card already mentioned as belonging to the present writer is endorsed 1756, so the Newton partnership probably took place about the time of William Newton's birth. It was William Newton who moved the place of business of Newton & Company, the successors of Nathaniel Hill, the successor of John Newton, from 128, Chancery Lane, to 66, Chancery Lane. William Newton was succeeded by his nephew Frederick Newton (1824-1909) who migrated to 3, Fleet Street. Mr. Herbert Charles Newton, now a member of the firm, was born in 1853.

Nathaniel Hill, Globe Maker & Engraver
at the Globe & Sun in Chancery Lane Fleet Street
London.
New and Correct Globes of 3 0.12.15 Inches Diameter.
ESTATES SURVEY'D, and MAPS
Neatly Drawn and Engraved.

FIGURE 336.

Trade Card of Nathaniel Hill, Globe Maker and Engraver, at the Globe and Sun, Chancery Lane, Fleet Street, about 1750.

Several interesting documents relating to the first phase in the history of the premier firm of scientific instrument-makers were discovered in the chamber above Temple Bar, when it was pulled down in January, 1878, and given by Messrs. Child to Mr. Frederic Newton. The letter reproduced in Figure 335 runs as follows :—

Mr. Child

I have at this time greater occasion for money than I have had for some years. I beg of you to desire Sr Francis . . . . told me he would pay for ye Globes at your return home to pay the same, viz 3 Guineas to my son who brings you this; I assure you it is not a pretence y^t I make use of this time to get ye money paid, but I really want it now: if you would procure it for me this morning, it would be as welcome as if it was given to

Sir

Yr humble s/vant

J. NEWTON

Please to give my most humble s/vice to S^r Francis

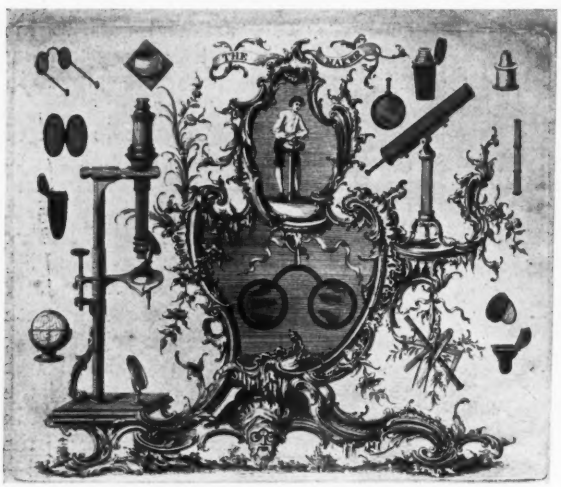


FIGURE 337.

Very curious optician's card of about 1750 showing the whole process of spectacle making. Certain emblems disclose the fact that the spectaclemaker in question was a Freemason.

FIGURE 338.

Trade Card of Richard Gearing, Mathematical Instrument Maker at the Quadrant without Newgate, facing the Old Bailey, cir. 1750.

Octo 26 1704

Rec^d then of S^r Francis Child for a pair of Globes the sum of three pounds.

J. NEWTON

M^r. Tho. Child
at y^e R^t Worp^{ll} S^r Fr Child
near Temple Barr
Lond

Other memoranda and accounts run thus :—

— Worp^{ll} S^r Francis Child ——
— Teaching his Son M^r Thomas Child ——
— viz. ——— of Geometry ——
Trigonometry Rectangular & Oblique angular & Plane Sayling
— for oblique sayling currents turning to Windward
Mercators sayling the Construction & use of the Plane.
& of Mercators Charts, the sum of six pounds — me

J. NEWTON.

FIGURE 339.

Trade Card of Benjamin Cole, a famous optician, carrying on business in Fleet Street, cir. 1760.

	£	s.	d.
viz. A Sector	4	6	0
A slyding Rule best (?) ...	0	5	0
Two folio papyr books ...	0	14	0
A slate	0	01	0
A pen (?)	0	03	6
A pair of slate Compasses ...	0	02	6
The use of a Drawer ...	0	01	0
	£5	13	0

It was in 1750 that the still-existing firm of Dollond, with its branches east and west of Temple Bar, was founded by John Dollond (see Figure 332), an active and prominent member of the Royal Society, which last month celebrated the two hundred and fiftieth anniversary of its incorporation. Dollond, born in June, 1706, was the son of a Huguenot refugee, a Norman weaver, who settled in Spitalfields, then the recognized centre of English silk-making. In spite of an imprudent early marriage and other difficulties, which to most men would have been insurmountable, Dollond made himself a master of many languages and many sciences.

The eventual trend of John Dollond's researches, however, was towards the kindred departments of astronomy and optics, and in 1750 he abandoned the weaver's craft and entered into an alliance with his son Peter Dollond—already an ardent scientific inquirer, one day to achieve distinction. They together became practising opticians, meanwhile

Ditto Rec[d] of y[e] R[t] Worp[ll] S[r] Francis Child y[e] sum of five pounds, 13 shillings & 6 pence in full of all Acc[t] disbursed by me for Books & Instrum[s]

engaging themselves enthusiastically in the work of investigation and improvement in connection with the instruments they fabricated. It is more than likely that Figure 337 of an interesting optician's card of this period emanated from the Dollonds, as it demonstrated very artistically and effectively the whole process of spectacle-making. If this surmise is correct one or other of the Dollonds must have belonged to the Order of Freemasons, which, in its present form originated in 1717, and between that date and 1750 was closely associated with the Royal Society. The discoveries of John Dollond overthrew a cherished theory of Sir Isaac Newton, and ended not only in the actual discovery of the achromatic telescope, but its practical application. In 1758 the Copley Gold Medal of the Royal Society (see Figure 333) was awarded to John Dollond, who, in 1761, was appointed Optician to George III. An invoice dated 1763 is shown in Figure 334. The house has continued from the hour of the foundation upon one unbroken course of development and expansion down to the present day. The traditions framed by John Dollond, the Huguenot weaver, and the principles he outlined upon which to conduct his business, remain unchanged, except where change has meant improvement.

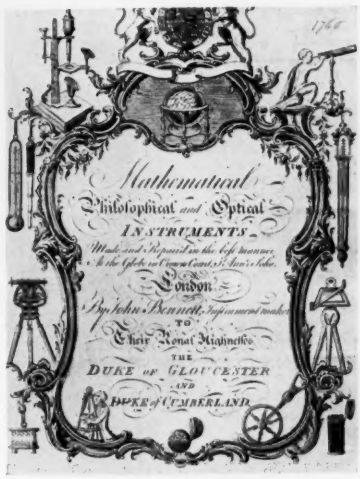


FIGURE 340.

Trade Card of John Bennett, Maker of Mathematical, Philosophical and Optical Instruments to the Dukes of Gloucester and Cumberland, at the sign of the Globe, Crown Court, St. Ann's, Soho, 1760.

FIGURE 341.

Trade Card of James Simons, Mathematical, Philosophical and Optical Instrument Maker, at the sign of Sir Isaac Newton's Head at the corner of Marylebone Street, opposite Glasshouse Street, 1785.

The most delicate and intricate weighing operations carried out by Messrs. Garrard, the Court Jewellers, are still performed with a machine of

INVENTED & MADE by R. RUST.
Removed from MINORIES to the Corner of
S[t] CATHERINES STAIRS Near
the TOWER of LONDON
AN ARTIFICIAL HORIZON

FIGURE 342.

Trade Card of R. Rust, Nautical Instrument Maker, at the corner of St. Catherine's Stairs, near the Tower of London, 1745.

XUM

Fisher Combes,
at ye Mariner & Globe in Broad Street near ye
Angel & Crown Tavern behind ye Royal Exchange
Maketh and Selleth all Sorts of
MATHEMATICAL INSTRUMENTS

FIGURE 343.

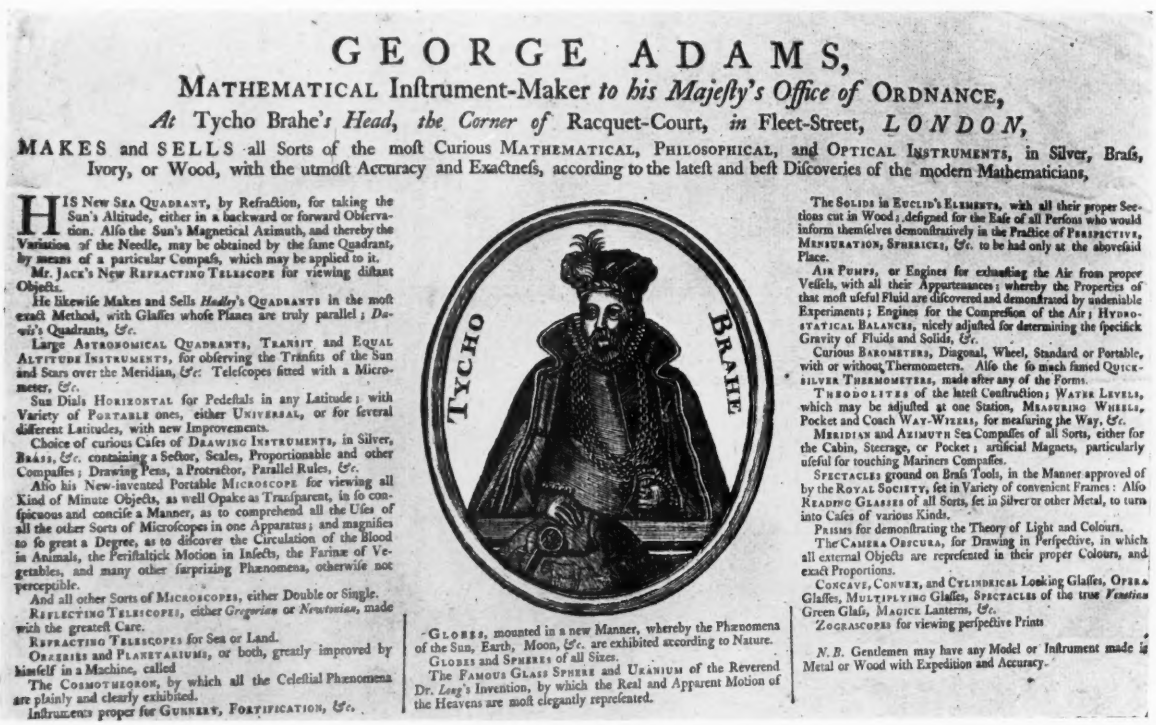
Trade Card of Fisher Combes, Maker of Mathematical and Nautical Instruments, at the sign of the Mariner and Globe, in Broad Street, near the Angel and Crown Tavern, behind the Royal Exchange, 1745.

marvellous precision, made in 1777 by the firm of De Grave, Short & Co., whose business as scientific scale-makers was founded in 1670 at the corner of St. Anne's Lane, now Gresham Street. The house of De Grave, Short, had been in existence more than sixty years, when the originators of the house of Garrard set up the sign of the Golden Lion, in the Haymarket. The balance of 1777 was one of the heirlooms which were removed with scrupulous care to the new home of the great firm in Albemarle Street. It is greatly to be regretted that the archives of the scale-makers, who have existed during portions of four centuries, have been lost. It seems likely that the founder of their business was, like John Dollond, a Huguenot.

Richard Gearing, whose fine card of the period

FIGURE 344.

Trade Card of William Watson, a Maker of Compasses and other Nautical Instruments, in Church Lane Stairs, Hull, 1755.



GEORGE ADAMS,

MATHEMATICAL Inſtrument-Maker *to his Majeſty's Office of* ORDNANCE,

At Tycho Brahe's *Head, the Corner of* Racquet-Court, *in* Fleet-Street, *LONDON*,

MAKES and SELLS all Sorts of the moſt Curious MATHEMATICAL, PHILOSOPHICAL, and OPTICAL INSTRUMENTS, in Silver, Braſs, Ivory, or Wood, with the utmoſt Accuracy and Exactneſs, according to the lateſt and beſt Diſcoveries of the modern Mathematicians,

HIS New SEA QUADRANT, by Refraction, for taking the Sun's Altitude, either in a backward or forward Obſervation. Alſo the Sun's Magnetical Azimuth, and thereby the Variation of the Needle, may be obtained by the ſame Quadrant, by means of a particular Compaſs, which may be applied to it.

Mr. JACK's NEW REFRACTING TELESCOPE for viewing diſtant Objects.

He likewiſe Makes and Sells *Hadley*'s QUADRANTS in the moſt exact Method, with Glaſſes whoſe Planes are truly parallel; *Davis*'s Quadrants, &c.

Large ASTRONOMICAL QUADRANTS, TRANSIT and EQUAL ALTITUDE INSTRUMENTS, for obſerving the Tranſits of the Sun and Stars over the Meridian, &c. Teleſcopes fitted with a Micrometer, &c.

Sun Dials HORIZONTAL for Pedeſtals in any Latitude; with Variety of PORTABLE ones, either UNIVERSAL, or for ſeveral different Latitudes, with new Improvements.

Choice of curious Caſes of DRAWING INSTRUMENTS, in Silver, BRASS, &c. containing a Sector, Scales, Proportionable and other Compaſſes; Drawing Pens, a Protractor, Parallel Rules, &c.

Alſo his New-invented Portable MICROSCOPE for viewing all Kind of Minute Objects, as well Opake as Tranſparent, in ſo conſpicuous and conciſe a Manner, as to comprehend all the Uſes of all the other Sorts of Microſcopes in one Apparatus; and magnifies to ſo great a Degree, as to diſcover the Circulation of the Blood in Animals, the Periſtaltick Motion in Inſects, the Farinæ of Vegetables, and many other ſurprizing Phænomena, otherwiſe not perceptible.

And all other Sorts of MICROSCOPES, either Double or Single.

REFLECTING TELESCOPES, either *Gregorian* or *Newtonian*, made with the greateſt Care.

REFRACTING TELESCOPES for Sea or Land.

ORRERIES and PLANETARIUMS, or both, greatly improved by himſelf in a Machine, called

The COSMOTHEORON, by which all the Celeſtial Phænomena are plainly and clearly exhibited.

Inſtruments proper for GUNNERY, FORTIFICATION, &c.

TYCHO BRAHE

GLOBES, mounted in a new Manner, whereby the Phænomena of the Sun, Earth, Moon, &c. are exhibited according to Nature.

GLOBES and SPHERES of all Sizes.

The FAMOUS GLASS SPHERE and URANIUM of the Reverend Dr. *Long*'s Invention, by which the Real and Apparent Motion of the Heavens are moſt elegantly repreſented.

The SOLIDS in EUCLID's ELEMENTS, with all their proper Sections cut in Wood; deſigned for the Eaſe of all Perſons who would inform themſelves demonſtratively in the Practice of PERSPECTIVE, MENSURATION, SPHERICKS, &c. to be had only at the abovemention'd Place.

AIR PUMPS, or Engines for exhauſting the Air from proper Veſſels, with all their Appurtenances; whereby the Properties of that moſt uſeful Fluid are diſcovered and demonſtrated by undeniable Experiments; Engines for the Compreſſion of the Air; HYDROSTATICAL BALANCES, nicely adjuſted for determining the ſpecifick Gravity of Fluids and Solids, &c.

Curious BAROMETERS, Diagonal, Wheel, Standard or Portable, with or without Thermometers. Alſo the ſo much famed QUICKSILVER THERMOMETERS, made after any of the Forms.

THEODOLITES of the lateſt Conſtruction; WATER LEVELS, which may be adjuſted at one Station, MEASURING WHEELS, Pocket and Coach WAY-WISERS, for meaſuring the Way, &c.

MERIDIAN and AZIMUTH Sea Compaſſes of all Sorts, either for the Cabin, Steerage, or Pocket; artificial Magnets, particularly uſeful for touching Mariners Compaſſes.

SPECTACLES ground on Braſs Tools, in the Manner approved of by the ROYAL SOCIETY, ſet in Variety of convenient Frames: Alſo READING GLASSES of all Sorts, ſet in Silver or other Metal, to turn into Caſes of various Kinds.

PRISMS for demonſtrating the Theory of Light and Colours.

The CAMERA OBSCURA, for Drawing in Perſpective, in which all external Objects are repreſented in their proper Colours, and exact Proportions.

CONCAVE, CONVEX, and CYLINDRICAL Looking Glaſſes, OPERA Glaſſes, MULTIPLYING Glaſſes, SPECTACLES of the true *Venetian* Green Glaſs, MAGICK Lanterns, &c.

ZOGRASCOPES for viewing perſpective Prints

N. B. Gentlemen may have any Model or Inſtrument made in Metal or Wood with Expedition and Accuracy.

FIGURE 345.

The Trade Card of George Adams, Mathematical Instrument Maker to His Majesty's Office of Ordnance, at the sign of Tycho Brahé's Head, at the Corner of Racquet Court in Fleet Street, 1775.

Henry Gregory
at ye Azimuth Compass, near ye India-House,
in Leaden-Hall Street LONDON.
Makes all Sorts of Mathematical Instruments,
for Sea or Land; Viz. Hadley's & Davies's Quadrants,
Theodolites, Plane Tables, Gauging & Drawing Instrum.
Telescopes at ye most Reasonable Rates.
All Sorts of Navigation Books & Sea Charts

FIGURE 346.

The Trade Card of Henry Gregory, Mathematical Instrument Maker, at the sign of the Azimuth Compass, near the India Office in Leaden-Hall Street, 1760.

Fleet Street,—a vicinity then evidently largely patronised by instrument-makers of all kinds. John Bennett, who enjoyed the countenance and support of the Dukes of Gloucester and Cumberland, apparently adopted the same sign as Cole (see Figure 339), but considerably further westwards, *viz.*, in Crown Court, St. Ann's, Soho. John Bennett's card, shewing the details of early thermometers and weather-glasses (see Figure 340) is surmounted by the royal arms, and bears a

FIGURE 349.

Bilingual Trade Card of John Chasson, a Surgical Instrument Maker, at the sign of the C and Cross in Newgate Street, cir. 1770.

in which John Dollond first "kept shop," is given in Figure 338, carried on business at the sign of the Quadrant, without the Old Bailey. He must have been a contemporary and neighbour of Nathaniel Hill, and so also were Benjamin Cole and Son, the orrery-makers at the Globe, in

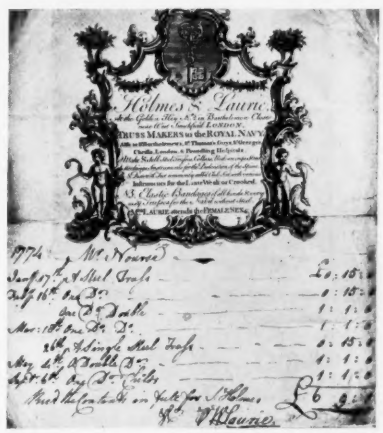


FIGURE 348.

Bill and Trade Card of Messrs. Holmes and Laurie, Makers of Surgical Appliances to the Royal Navy, at the sign of the Golden Key, in Bartholomew Close, West Smithfield, 1774.

strong resemblance to that issued by his neighbour, James Simons (see Figure 341), of the Sir Isaac Newton's Head at the corner of the now vanished Marylebone Street, opposite Glass House Street. In Simons' we have a sun-dial, and a microscope, besides a globe, telescope and orrery. Its date is 1785.

Naval historians cannot fail to be interested in the 1745 trade card of Robert Rust (see Figure 342), nautical instrument-maker at the corner of St. Catherine's Stairs, near the Tower of London. One of Rust's formidable rivals must have been Fisher Combes (see Figure 343), who carried on busi-

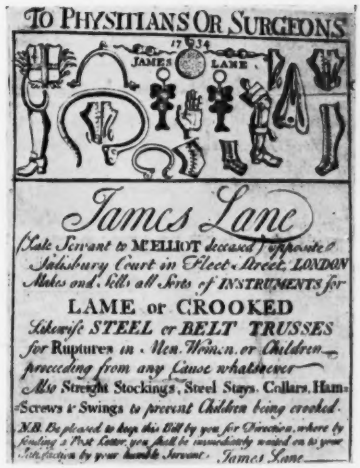

TO PHYSITIANS OR SURGEONS
JAMES LANE
James Lane
Late Servant to M.ELLIOT deceased Opposite to
Salisbury Court in Fleet-Street LONDON
Makes and Sells all Sorts of INSTRUMENTS for
LAME or CROOKED
Likewise STEEL or BELT TRUSSES
for Ruptures in Men Women or Children
proceeding from any Cause whatsoever
Also Strong Stockings, Steel Stays, Collars, Ham-
Screws & Swings to prevent Children being crooked.
N.B. Be pleased to keep this Bill by you for Direction, where by
sending a Post Letter you shall be immediately waited on to your
Satisfaction by your humble Servant James Lane

FIGURE 347.

Trade Card of James Lane, Maker of Surgical Appliances, Opposite Salisbury Court in Fleet Street, 1734.

ness in the same kind of scientific instruments at the sign of the Mariner and Globe in Broad Street, near the Angel and Crown Tavern, behind the Royal Exchange. It is somewhat difficult nowadays to understand the necessity of describing Broad Street as being in the vicinity of the Angel and Crown, or any other inn. The compass-card (1755) of William Watson (see Figure 344), of Church Lane Stairs, Hull, needs no explanation. It shews that the making of nautical and other scientific instruments was not a monopoly of the Metropolis. Henry Gregory (1760) was evidently another maker of nautical accessories (see Figure 346) who prospered in the very heart of London city,

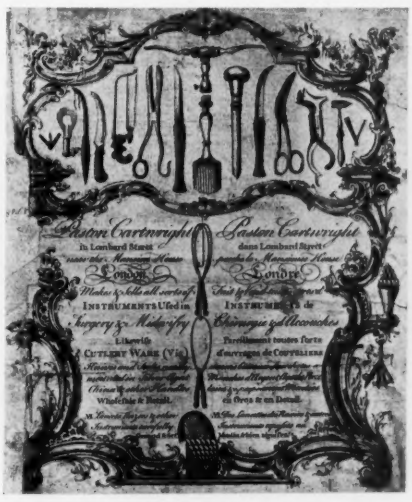


FIGURE 350.

Bilingual Trade Card of Paston Cartwright, Surgical Instrument Maker, of Lombard Street, 1770.

XUM

viz., "at the sign of the Azimuth and Compass, near the India House, in Leaden Hall Street. Gregory offers for sale all sorts of navigation books and sea charts, and advertises, amongst other things, Hadley's and Davise's Quadrants, Theodolites, Plain Tables, Gauging and Drawing Instruments and Telescopes at most Reasonable Rates."

The business card of George Adams, "Mathematical Instrument-Maker *to His Majesty's Office of Ordnance*" at Tycho Brahé's Head, the corner of Racquet Court, in Fleet Street, is an exceptionally interesting one. (See Figure 345.) It is difficult to understand Mr. Chancellor's omission of any mention whatever of the colony of scientific instrument-makers which formed one of the most interesting features of the Fleet Street of Johnson, Goldsmith and Boswell. The cards of the manufacturers of surgical appliances have been left to the last. The oldest of them all, James Lane, whose very curious trade card bears on the face of it in print, the date 1734 (see Figure 347), was also a Fleet Street worthy, with a shop opposite Salisbury Court in Fleet Street. He advertises "streight stockings, steel stays, collars, ham-screws and swings to prevent children being crooked." John Chasson, who issued a card with the text in both French and English (see Figure 349), lived in Newgate Street, at the sign of the "C. and Cross" (du C et de la Croix) concerning which the writer will welcome any explanation. Paston Cartwright (see Figure 350), in 1770, flourished amongst the bankers and notable merchants in Lombard Street, "near the Mansion House." He possibly enjoyed the support of the Lord Mayor, but, like Chasson, he found it advisable to use a bilingual trade card. Of all these eighteenth-century cards none presents more delicate artistic features than the bill-head of Holmes & Laurie, of Bartholomew Close, West Smithfield. (See Figure 348.) It is rendered specially interesting by the bill set out beneath it, which, receipted apparently by one of the heads of the firm, shows the exact date (1774), at which it enjoyed the distinction of being Truss-makers to the Royal Navy.

SOLAR DISTURBANCES DURING JUNE, 1912.

By FRANK C. DENNETT.

DURING the month of June, the Sun was apparently quite free from disturbance on eight days—3rd, 4th, 10th, 11th, 13th to 15th and 30th—whilst only faculae were seen on six—5th to 9th and 29th. The longitude of the central meridian at noon on the 1st was 311° 58′.

No. 7.—A disturbance belonging to May which continued visible until June 2nd and accordingly re-appears upon the present chart.

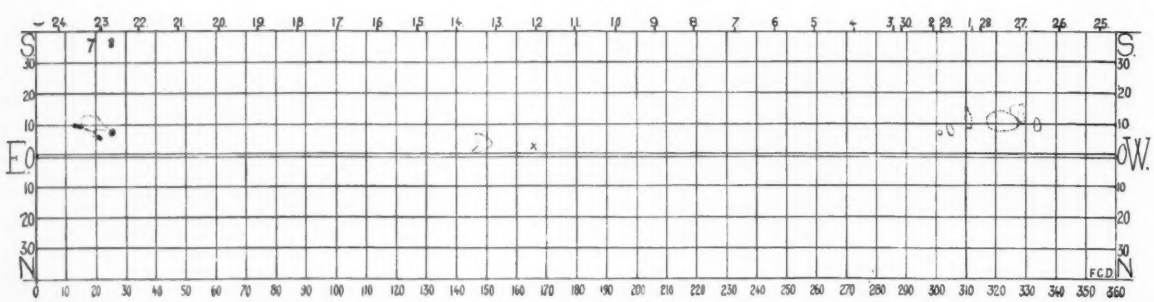
Upon the 12th a small pore was visible but its position was not measured; however, it could not have been far from 165° where a little cross is marked, although it may possibly have been upon the other side of the equator.

No. 8.—A spot first seen on the afternoon of June 16th, close to the eastern limb, in south latitude 8°, and having a diameter of eleven thousand miles. During its transit across the disc the diameter at first increased to fifteen thousand miles; it also had a proper motion which carried it its own diameter nearer the equator. Nearly all the time it was visible the penumbra was noticed to brighten towards its inner border. The darker nuclei within the umbra were well shown. A tiny pore was suspected amid the bright faculae, which extended away toward the south-east on the 18th. A pore was also seen here on the 20th, whilst two were visible on the 23rd. The spot seemed to be shrinking somewhat when last seen a little within the western limb on the 28th.

Faculae were seen on June 5th in longitude 317°—327°, S. latitude 8°—14°; and on the 6th, the knot and streak at longitudes 301° and 305° degrees respectively. On the 8th, the disturbance in longitude 145°—152°, S. latitude 0°—7° was within the eastern limb. On the 18th, a bright knot was approaching the western limb in somewhat high northern latitude, and on the 19th, a small one near longitude 154°, at 54° N latitude. From June 21st until the 24th, faculae were seen from longitude 325° to 335°, S. latitude 8°—17°, and longitude 309°—312°, S. latitude 9°—15°, the return of the April disturbance. On the 29th, the faculic following of No. 8 was still visible within the western limb.

Our chart is constructed from the combined observations of Messrs. J. McHarg, A. A. Buss, E. E. Peacock, C. Frooms, D. Booth, and the writer.

DAY OF JUNE, 1912.



THE FACE OF THE SKY FOR SEPTEMBER.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

Date.	Sun.		Moon.		Mercury.		Venus.		Jupiter.		Saturn.		Uranus.	
	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Sept. 2	10 44·7	N. 8·0	2 43·7	N.18·7	9 42·4	N.12·3	11 46·0	N. 2·9	16 20·9	S.21·0	4 9·4	N.18·9	20 9·5	S.20·7
,, 7	11 2·8	6·1	7 44·9	N.26·5	9 55·1	12·7	12 8·5	N. 0·3	16 22·9	21·1	4 9·8	18·9	20 9·0	20·8
,, 12	11 20·8	4·2	12 28·9	S. 2·6	10 19·1	11·7	12 30·9	S. 2·2	16 25·2	21·2	4 10·1	18·9	20 8·5	20·8
,, 17	11 38·7	2·3	16 51·5	S. 27·2	10 50·2	9·2	12 53·4	S. 4·8	16 27·8	21·3	4 10·1	18·9	20 8·1	20·8
,, 22	11 56·7	N. 0·4	21 15·0	S. 20·6	11 23·7	5·9	13 16·1	S. 7·3	16 30·6	21·4	4 10·0	18·9	20 7·8	20·8
,, 27	12 14·7	S. 1·6	0 57·3	N. 6·5	11 57·3	N. 2·2	13 39·0	S. 9·8	16 33·6	S.21·5	4 9·7	N.18·8	20 7·5	S.20·8

TABLE 31.

Date.	Sun.			Moon.	Jupiter.						Saturn.	
	P	B	L	P	P	B	L_1	L_2	T_1	T_2	P	B
Greenwich Noon.	°	°	°	°	°	°	°	°	h m	h m	°	°
Sept. 2	+21·5	+7·2	161·8	−16·3	+ 9·6	−2·6	194·2	184·8	4 33 *e*	6 55 *m*	−3·2	−25·1
,, 7	22·7	7·3	95·7	+10·0	9·4	2·6	262·8	215·3	2 40 *e*	4 0 *e*	3·2	25·1
,, 12	23·7	7·2	29·7	+20·5	9·1	2·6	331·4	245·7	2 57 *m*	3 10 *e*	3·2	25·1
,, 17	24·6	7·2	323·7	+ 6·2	8·9	2·6	39·9	276·1	8 46 *e*	4 24 *m*	3·2	25·1
,, 22	25·3	7·0	257·7	−16·8	8·6	2·6	108·4	306·4	9 3 *m*	11 25 *e*	3·2	25·1
,, 27	+25·8	+6·8	191·7	−21·3	+ 8·3	−2·6	176·8	336·7	5 1 *e*	2 43 *m*	−3·2	−25·1

TABLE 32.

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zones. T_1 T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN moves South pretty rapidly. Sunrise during September changes from 5–13 to 5–59; sunset from 6–47 to 5–41. Its semi-diameter increases from 15′ 53″ to 16′ 0″. The autumnal Equinox is passed $23^d\ 10^h m$.

MERCURY is a morning star, well placed for observation early in the month. On September 1st, one-fifth of disc is illuminated, semi-diameter $4\frac{1}{2}''$; on September 30th, the disc is fully illuminated, semi-diameter $2\frac{1}{2}''$.

VENUS is an evening Star, but too near the Sun for convenient observation. Illumination nearly complete, semi-diameter $5\frac{1}{2}''$.

THE MOON.—Last Quarter $4^d\ 1^h\ 23^m e$; New $11^d\ 3^h\ 48^m m$; First Quarter $18^d\ 7^h\ 55^m m$; Full $26^d\ 11^h\ 34^m m$. Perigee $9^d\ 6^h e$, semi-diameter 16′ 37″; Apogee $21^d\ 8^h e$, semi-diameter 14′ 46″. Maximum Librations, September 3^d, 7° E., 6^d 7° S., 15^d 7° W., 20^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

Date.	Star's Name.	Magnitudes.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. to E.	Mean Time.	Angle from N. to E.
1912.			h. m.		h. m.	
Sept. 3 ...	τ^1 Arietis	5·2	1 39 *m*	88°	2 44 *m*	215°
,, 3 ...	36 Tauri	5·6			9 4 *e*	298
,, 4 ...	χ Tauri	5·3	4 45 *m*	22	5 35 *m*	302
,, 18 ...	γ^1 Sagittarii	Var.	4 34 *e*	121	5 50 *e*	247
,, 19 ...	BAC 6525	6·2	9 8 *e*	77	10 23 *e*	253
,, 22 ...	37 Capricorni	5·7	6 18 *e*	131	6 51 *e*	181
,, 22 ...	ϵ Capricorni	4·7	7 58 *e*	37	9 14 *e*	265
,, 22 ...	κ Capricorni	4·8	11 51 *e*	78	0 56* *m*	218
,, 25 ...	χ Aquarii	5·3	3 0 *m*	75	3 59 *m*	221
,, 25 ...	24 Piscium	6·1	9 22 *e*	35	10 34 *e*	250
,, 28 ...	BD+12° 271	6·3			6 44 *e*	265
,, 30 ...	BAC 976	6·7			3 59 *m*	221
,, 30 ...	ζ Arietis	4·8	6 3 *m*	77	7 8 *m*	250

TABLE 33. Occultations of stars by the Moon visible at Greenwich.

From New to Full disappearances occur at the Dark Limb, from Full to New reappearances.

The asterisk indicates the day following that given in the date column.

XUM

MARS is an evening Star, but practically invisible.

JUPITER is an evening Star, increasing its distance from us, so that the equatorial semi-diameter diminishes from 19″ to 17″. The Polar is smaller by 1¼″. The configurations of the satellites at $7^h\ 30^m$ *e* are for an inverting telescope.

Day.	West.	East.	Day.	West.	East.
Sept. 1	23 ○ 14		Sept. 16	321 ○ 4	
,, 2	3¹2 ○ 4		,, 17	3 ○ 124	
,, 3	3 ○ 124		,, 18	31 ○ 24	
,, 4	31 ○ 24		,, 19	2 ○ 134	
,, 5	21 ○ 43		,, 20	2 ○ 34	1●
,, 6	4 ○ 13	2●	,, 21	1 ○ 243	
,, 7	41 ○ 23		,, 22	2 ○ ¾ 1	
,, 8	423 ○ 1		,, 23	3¹4 1 ○	
,, 9	4321 ○		,, 24	¾ ○ 21	
,, 10	43 ○ 12		,, 25	431 ○ 2	
,, 11	431 ○ 2		,, 26	42 ○ 1	3●
,, 12	42 ⊙ 3		,, 27	421 ○ 3	
,, 13	4 ○ 3	2● 1●	,, 28	4 ⊙ 23	
,, 14	1 ○ 423		,, 29	4 ⊙ 13	
,, 15	2 ⊙ 14		,, 30	2341 ○	

TABLE 34.

Satellite phenomena visible at Greenwich, $1^d\ 6^h\ 43^m$ III. Sh. E.; $4^d\ 7^h\ 55^m$ I. Oc. D., $9^h\ 22^m$ II. Tr. I.; $5^d\ 7^h\ 26^m$ I. Tr. E., $8^h\ 44^m$ I. Sh. E.; $6^d\ 9^h\ 27^m\ 35^s$ II. Ec. R.; $8^d\ 8^h\ 17^m$ III. Sh. I.; $12^d\ 7^h\ 9^m$ I. Tr. I., $8^h\ 25^m$ I. Sh. I.; $13^d\ 6^h\ 51^m$ II. Oc. D., $7^h\ 47^m\ 36^s$ I. Ec. R.; $15^d\ 6^h\ 29^m$ II. Sh. E., $7^h\ 15^m$ III. Tr. I.; $20^d\ 6^h\ 17^m$ I. Oc. D.; $21^d\ 7^h\ 4^m$ I. Sh. E.; $22^d\ 6^h\ 22^m$ II. Sh. I., $6^h\ 41^m$ II. Tr. E.; $26^d\ 6^h\ 27^m\ 12^s$ III. Ec. D.; $28^d\ 6^h\ 44^m$ I. Sh. I., $7^h\ 49^m$ I. Tr. E.; $29^d\ 6^h\ 6^m\ 4^s$ I. Ec. R., $6^h\ 40^m$ II. Tr. I.

All the above are in the evening hours.

The eclipse reappearances of I. II. and both phases of those of III. occur high right of the inverted image, taking the direction of the belts as horizontal.

Mr. A. Burnet points out that the star ω Ophiuchi (magnitude 4½) will be occulted by Jupiter on September 15th.

Disappearance about $9^h\ 25^m e$, Angle N. to E. 138°.

Reappearance ,, $10^h\ 47^m e$, ,, ,, ,, 237°.

The disappearance may be seen from Lisbon, Rio or the Cape; the reappearance from Rio, La Plata or Cordoba.

SATURN is a morning Star. Polar semi-diameter 8¾″. The major axis of the ring is 44″, the minor axis 18¾″. The ring is now approaching its maximum opening and projects beyond the poles of the planet.

East elongations of Tethys (every fourth given). September $2^d\ 9^h{\cdot}3\ m$, $9^d\ 10^h{\cdot}5\ e$, $17^d\ 11^h{\cdot}7\ m$, $25^d\ 0^h{\cdot}9\ m$. Dione (every third given). September $2^d\ 8^h{\cdot}7\ m$, $10^d\ 1^h{\cdot}8\ e$, $18^d\ 6^h{\cdot}8\ e$, $26^d\ 11^h{\cdot}9\ e$.

Rhea (every second given). September $1^d\ 2^h{\cdot}3\ m$, $10^d\ 3^h{\cdot}2\ m$, $19^d\ 4^h{\cdot}0\ m$, $28^d\ 4^h{\cdot}8\ m$.

For Titan and Iapetus, E. W. mean East and West elongations, I., S. Inferior and Superior Conjunction, Inferior being to the North, superior to the South. Titan, $5^d\ 6^h{\cdot}7\ m$ S., $9^d\ 10^h{\cdot}3\ m$ E., $13^d\ 11^h{\cdot}2\ m$ I., $17^d\ 7^h{\cdot}1\ m$ W., $21^d\ 5^h{\cdot}7\ m$ S., $25^d\ 9^h{\cdot}0\ m$ E., $29^d\ 9^h{\cdot}6\ m$ I. Iapetus $15^d\ 11^h{\cdot}8\ m$ I.

URANUS is an evening Star, semi-diameter 2″. It is 7½° South of Alpha Capricorni, 5° South-West of Beta.

NEPTUNE is a morning star, but badly placed.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
June to Sept.	335°	+ 57°	Swift.
July 25 to Sept. 15	48	+ 43	Swift, streaks.
July to Sept.	335	+ 73	Swift, short.
July to Oct...	355	+ 72	Swift, short.
Aug., Sept. ..	353	− 11	Rather slow.
Aug., Sept....	346	0	Slow.
Aug. to Oct. 2	74	+ 42	Swift, streaks.
Aug., Sept ..	63	+ 22	Swift, streaks.
Sept. 5—15	62	+ 35	Swift, streaks.
,, 6—17	106	+ 52	Swift, streaks.
,, 15—24	14	+ 6	Slow.
,, 21 ...	31	+ 19	Slow, trains.
,, 27, 30 ...	4	+ 28	Slow.
Sept. 28 to Oct. 9	320	+ 40	Slow, small.

CLUSTERS AND NEBULAE.

Name.	R.A.	Dec.	Remarks.
M. 15	$21^h\ 26^m$	N 11°·8	Cluster.
M. 2	21 29	S 1 ·2	Cluster.
M. 39	21 30	N 48 ·1	Cluster.
M. 30	21 36	S 23 ·5	Cluster.
♅ VIII. 75	22 12	N 49 ·5	Cluster.

DOUBLE STARS.—The limits of R.A. are 21^h to 23^h.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Angle. N. to E.	Distance.	Colours, etc.
Σ 2751	21 0	N 56°·3	6, 7	350°	2″	White.
61 Cygni	21 3	N 38 ·3	5, 6	128	23	Yellow.
δ Equulei	21 10	N 9 ·7	4, 10	16	48	Yellow, blue.
The principal star is a very close double, period 5·7 years						
Piazzi xxi. 51	21 11	N 59 ·7	6, 7	222	1	White.
Lalande 41776	21 25	N 10 ·7	6½, 6¼	295	1½	White.
β Cephei	21 28	N 70 ·2	3, 8	250	13	Greenish, blue.
μ Cygni	21 40	N 28 ·4	4, 5	122	2	Yellow, blue.
κ Pegasi	21 41	N 25 ·3	4, 10	296	12½	Yellowish.
The principal star is a very close double, period 11·4 years.						
ξ Cephei	22 2	N 64 ·2	4½, 6	283	7	Yellow, blue.
ξ Aquarii	22 24	S 0 ·4	4, 4	319	3	Greenish.
37 Pegasi	22 26	N 4 ·0	6, 7	140	½	White.
8 Lacertae	22 32	N 39 ·2	6, 6	185	17	White.
Two other stars, mags. 8 and 10, belong to the system.						
Bradley 3028	22 48	N 61 ·3	6, 7	305	2	Yellow, ash.

TABLE 35.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

PROFESSOR J. C. KAPTEYN'S REPORTS ON THE PROGRESS OF WORK ON HIS SELECTED AREAS.—It will be remembered that a few years ago Professor Kapteyn made the suggestion that as the problem of finding the position, motion, spectrum and magnitude of every visible star was too vast for our resources, it would be well to select a series of small areas uniformly distributed over the sky, and that the stars in these areas should be studied with the greatest possible care. He anticipated that in this way most valuable data about the structure of the stellar universe might be acquired in a comparatively short time. He was fortunate in obtaining such a large measure of support for his plan that it is already well under weigh, and the reports now to hand take stock of the results acquired and make suggestions for the future. The work of organisation was felt to be beyond the power of one man, and a committee has been formed, consisting of Professor Kapteyn, Sir David Gill, Professors E. C. Pickering, G. E. Hale, F. Küstner, K. Schwarzschild, F. W. Dyson (Astronomer-Royal), and W. S. Adams.

The following are the positions of the selected areas.

The North Pole:—

Decl. 75° N.	R.A. 0^h 0^m	and every fourth hour.
Decl. 60 N.	R.A. 1 0	and every alternate hour.
Decl. 45 N.	R.A. 0 40	and every hour.
Decl. 30 N.	R.A. 0 25	„ „ „
Decl. 15 N.	R.A. 0 10	„ „ „
Decl. 0	R.A. 0 50	„ „ „
Decl. 15 S.	R.A. 0 15	„ „ „

And a similar continuation for the Southern sky.

The problem of finding accurate magnitudes is now undertaken far more carefully than it used to be, as very important questions of the structure of the universe and the possible absorption of light in space depend upon it.

The method mainly used is photographic, each region being photographed on the same plate as the standard polar area, the magnitudes in it having been determined at Harvard with the aid of some plates taken with the sixty-inch reflector at Mount Wilson, showing stars down to the twenty-first magnitude. A series of Durchmusterung plates of the selected regions is being taken by Professor E. C. Pickering, using originally the twenty-four inch Bruce telescope, focal length eleven feet, and subsequently the sixteen-inch Metcalf telescope, focal length seven and a half feet. These plates give tolerably good positions and accurate magnitudes and numbers of stars. They go down to the sixteenth magnitude. and contain about thirteen thousand stars per square degree in the Galaxy, which number falls to six hundred per square degree 60° from the Galaxy.

The next item in the work is a series of parallax plates of the selected regions. The Cape Observatory is active in this field in the Southern Hemisphere, and has taken one hundred and seventy-six finished plates.

Father Chevalier, at Zo-Sè (China) is undertaking a small region, and the Allegheny and Yerkes Observatories are also coöperating. At least two exposures are made on each plate six months apart, and either a third exposure six months later or a second pair of exposures on another plate (three exposures at half-yearly intervals being required to eliminate proper motion). These are all taken near the meridian, so that the effect of atmospheric dispersion, arising from slightly different colours of stars, is practically constant. This involves taking the region at about six o'clock a.m. at the first exposure, and six p.m. at the second.

PROPER MOTIONS.—A similar series of plates is being taken to obtain the proper motions of the fainter stars, but the interval must be at least ten years for useful results. It is proposed to keep the plates undeveloped, and re-expose after the interval; this, however, is not an essential, and a beginning can be made by comparing recent plates with those taken for the Carte du ciel ten or fifteen years ago. Besides the observatories mentioned above the Radcliffe Observatory, Oxford, is taking proper motion plates with the twenty-four inch equatorial, and photographs are being taken with the sixty inch reflector at Mt. Wilson of the centres of the selected areas. The region of good definition on these plates is only 25′ across, but they will enable the magnitudes and countings, and in time the proper motions, to be extended to the eighteenth magnitude.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

VEGETABLE PROTEINS.—Much interesting work has been done during the last few years on the proteins occurring in plants. These bodies are the most complex organic substances known, and they are of great importance from the fact that the protoplasm of plants and animals—"the physical basis of life"—consists essentially of proteins.

Zaleski (*Beih. Bot. Centralbl.*, Band XXVII, Abt. I) has studied the transformation of nitrogenous materials in ripening seeds, in their relation to the synthesis of proteins. He finds that various organic nitrogen-containing substances, simpler than proteins, are transformed to proteins during ripening. His method is to remove green peas from the pod and make determinations of the nitrogen in proteins, in amino-acids, and in organic bases; sets of young seeds are taken and treated in this way from time to time, part of each set being analysed at once, the rest after a week, and the analyses compared. In all cases considerable amounts of amino-acids and organic bases were transformed into proteins during storage of the seeds. In peas the synthesis was less than half as rapid in the absence of carbon dioxide as in its presence; drying of the seeds hastened the synthesis considerably.

According to Zaleski, the amino-acids resulting from the hydrolysis of a plant protein are the ones involved in its synthesis, the two processes being phases of a reversible reaction. This view is taken by various recent investigators, and is opposed to the older views that asparagin is the immediate material from which plant proteins are built up, or that proteins may be synthesised by the introduction of ammonia into simple organic compounds. Possibly the same enzymes (ferments) cause both the building-up and the breaking-down of proteins.

DEVELOPMENT OF LAMINARIACEAE.—As noted in these columns some time ago ("KNOWLEDGE," September 1910), it has been found that the so-called "zoöspores" of *Laminaria*, the "sea tangle," are in reality sexual cells (zoögametes) which fuse in pairs, the resulting fusion-cell (zygote) producing a chain or mass of cells from which the *Laminaria* plant arises.

Killian (*Zeitschrift für Botanik*, III) has made a thorough investigation of the early growth of *Laminaria* from the confervoid protonema stage, and has also brought together the scattered though extensive literature of the Laminariaceae, adding many interesting observations of his own regarding the anatomy, regeneration, and general biology of this group. He finds that from the primary few-celled protonema there arise secondary protonemata which for a time undergo repeated cell-divisions in all directions and remain at first uniform in structure, but later there is localised growth and specialisation of the tissues. All the tissues are genetically connected together. The inner tissues are distinguished by their feeble power of growth and division, hence they play a passive part and their original arrangement undergoes disturbance; the primary connections between these inner tissues are lost, and new tissue-elements are interpolated from the outer zone. The Laminariaceae agree closely in histological structure with the Fucaceae. All parts of a *Laminaria* plant respond rapidly to wound stimuli, regeneration being quickly and completely effected when these parts are injured by cuts

XUM

in different directions; regeneration is due in all cases to the growth of the active outer tissues.

Yendo (*Annals of Botany*, XXV) has investigated the early development of species of *Laminaria*, *Costaria*, and *Undaria*, and adds considerably to previous records regarding the stages from sporeling to adult plant in the Laminariaceae. The young plant is filamentous, growing by a single apical cell, then longitudinal division occurs in the youngest segment (the cut just below the apical cell) and the two cells thus formed, lying side by side, grow so that the upper part of the plant becomes a single-layered expansion, supported on a filamentous stalk. By further divisions, the expanded portion or blade becomes two-layered, while the stalk becomes a cylinder consisting of several rows of cells, while a meristematic, or actively growing and dividing, zone appears at the junction between blade and stalk. Apical growth gradually diminishes as development proceeds, and finally ceases. A single "pre-cortical" layer of large cells is developed at the transition region, between the already existing two layers; then this pre-cortex grows in thickness and sends inwards thread-like outgrowths which give rise to the loose central tissue or medulla.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON.), F.I.C.

SENSITIVENESS OF BIRDS AND MICE TO CARBON MONOXIDE.—A *Technical Paper* by Mr. G. A. Burrell, has just been published by the Bureau of Mines, Washington. It is shown that the production of a cap upon the flame in a safety lamp is not a reliable method of detecting the presence of carbon monoxide in the gases in mines after explosions or fires. A more sensitive means is to test the air with cuprous chloride solution or with blood solution, though both of these are inferior to the use of mice or small birds as indicators. As an example, it is mentioned, that on one occasion Mr. Burrell himself had remained for over twenty minutes in a room, the atmosphere of which contained 0·25 per cent. of carbon monoxide, and at the time experienced no ill-effects beyond a slight headache, although subsequently he became ill; whereas canaries under the same conditions showed indications of distress within a minute and fell down within five minutes. Mice are also much more sensitive than human beings to the action of the gas, though they do not show the effects so soon as birds. The method has already shown its value in practice, as is shown by the following instance. A number of persons exploring a mine took with them a canary, and on reaching a certain place the bird fell from its perch. The party at once retreated without having suffered ill-effects, although a subsequent analysis of the air at this spot showed that it contained from 0·25 to 0·3 per cent. of carbon monoxide.

ACTION OF ACIDS ON CONCRETE.—The cause of the rapid disintegration of concrete drains—in many cases soon after they have been laid—has been investigated by Dr. E. Neumann (*Tonind. Zeit.*, 1912, XXXVI, 601). The results of the experiments showed that in every instance the concrete had been acted upon by an acid, either from without or within. Thus, in one case the soil in which the concrete was laid contained iron pyrites, by the decomposition of which in the presence of the water in the soil, sulphuric acid was produced. In other cases sulphuretted hydrogen within the drains became partially oxidised to sulphuric acid. Other acids, such as acetic, hydrochloric or oleic acid, also act upon concrete, though these are not likely to be of such common occurrence as sulphuric acid. The latter appears to produce its injurious effect by decomposing the aluminium and calcium compounds in the concrete to form sulphates (especially calcium sulphate), and in the production of these a considerable increase in the volume of the material takes place. Acids also act by converting some of the constituents of the concrete into soluble salts, notably calcium bicarbonate, which are then gradually dissolved by the water, so that the material falls to pieces.

As a remedy it is suggested that the concrete should be made of dense clinker and contain as little lime as possible, and that the foundations of the drain and all exposed places should be protected with asphalt or tar. In addition to these external precautions means must be provided for the effective ventilation of the interior.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

A FORMER COURSE OF THE THAMES.—An interesting suggestion as to a former course of the Thames is made in a paper by Dr. R. L. Sherlock and Mr. A. H. Noble in *The Quarterly Journal of the Geological Society* for June, 1912. They also deal with the clay-with-flints of Buckinghamshire, which they believe to be of glacial origin. They regard it as representing the product of the waste of ages of the chalk and Eocene outliers, swept up by an ice-sheet from the north or north-west, and spread out as the incoherent material spoken of as the "clay-with-flints." If the chalk solution theory of its origin be regarded as disproved, the glacial theory is the only one consistent with the general character of the deposit and the unworn nature of its flints. The clay with flints is accompanied by a glacial gravel consisting entirely of flint. It must be distinguished from the fluvioglacial or plateau-gravels generally lying at a lower level and characterised by containing a certain amount of material from distant sources. The plateau-gravels lie to the south and south-east of the clay-with-flints area. The far-travelled pebbles occur abundantly in a belt three to four miles wide, running parallel with and including the present valley of the Thames from Hurley to Bourne End, continuing in the same east-north-east direction through Beaconsfield and Chalfont to the Colne valley. These pebbles must have been brought into their present position by the Thames, and their distribution seems to point to a former course of the Thames at the foot of the Eocene escarpment from Bourne End to Rickmansworth, and from thence to Watford along the line of the Colne, which occupies a part of the old valley. The level of the gravels and the number of far-travelled pebbles fall off from the Thames towards Watford, and thus afford corroborative evidence for this view. The diversion of the Thames towards the south at Bourne End is believed to have been accomplished by the movement of the ice-sheet across the old Thames valley, forcing the water to escape over a col by way of Maidenhead.

Pertinent criticism in the ensuing discussion turned upon the definition of clay-with-flints and whether all clay-with-flints—for example, that of Surrey—was to be regarded as of glacial origin. The question was also asked whither the authors proposed to send the Thames after it had reached Watford—a question they preferred to leave unanswered until they had examined the country east of Watford.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE weather of the week ended June 15th, as set out in the Weekly Weather Report issued by the Meteorological Office, was very unsettled, with frequent rains. Thunderstorms were reported on each of the first five days of the week, and these were in many cases accompanied by heavy rain or hail.

Temperature was below the average in all districts except England, E., but the variation was nowhere very great. The highest readings reported were 73° at Cullompton and Camden Square, and 71° at Greenwich and Southampton. At Lerwick the maximum for the week was only 52°, and at Wick 53°. In Guernsey the maximum was 66°. The lowest readings were 37° at Llandrindod Wells, and 39° at Cahir, Markree, and Marlborough. On the grass the lowest readings reported were 31° at Birmingham, and 33° at Buxton and Dublin (Phoenix Park).

The temperature of the soil at one foot depth was below the average very generally; at a depth of four feet it was almost normal.

Rainfall was in excess in all districts except the English Channel, where it was only half as much as usual. In many parts of the Kingdom, however, it was more than double, and in England, N.E., it was nearly three times the average. At Alnwick Castle the total for the week was 2·36 inches or more than five times the average amount, 0·44 inch.

Sunshine was above the average in England, E., S.E., the Midland Counties and in Ireland, S., but below it elsewhere. The variations were somewhat remarkable, England, E., having the largest daily average, 8·2 hours (50%) and Scotland, E., the smallest daily average, 1·3 hours (7%). In the one case the daily value was 1·7 hours above the average; in the other case it was 4·6 hours below it.

The mean temperature of the sea water varied from 48°·2 at Berwick to 59°·7 at Margate and Seafield.

The weather of the week ended June 22nd continued very unsettled in the West and North, with frequent heavy falls of rain. Over the south-eastern counties, however, the weather improved after the 17th. Thunderstorms were reported on the 16th, 19th, and 22nd.

Temperature was above the average in the greater part of England and in the English Channel, but was below it in Scotland and Ireland. The excess was greatest in England, E., where the district value was 60°·3 as compared with the average of 57°·8. Some very high temperatures were recorded during the week, the highest being 84° at Greenwich, 83° at Hampstead and Camden Square and 82° at Tunbridge Wells. The lowest of the minima were 35° at Balmoral and 37° at West Linton, Poltolloch and Kilmarnock. Ground frost was reported at Crathes (29°), Newton Rigg (30°) and Balmoral and Glasgow (32°).

The temperature of the soil at one foot depth was above the average at most of the English stations, but below it in Scotland and Ireland. At a depth of four feet it was very close to the normal.

Rainfall was in excess except in England, E., S.E., the Midlands and the English Channel. In Scotland, W., and in Ireland the total precipitation was about three times as much as usual; in England, S.E., and the English Channel it was less than one-third the average.

Bright sunshine was in defect except in England, E. and S.E. The district values varied from 8·5 hours (51%) in England, E., to 2·5 hours (15%) in Ireland, S. The sunniest stations were Greenwich with a daily average of 9·2 hours (56%) and Southend 9·1 hours (55%), while at Balruddery near Dundee the value was only 1·9 hours (11%). At Westminster the average daily duration was 8·3 hours (51%). The mean temperature of the sea water ranged from 49°·4 at Lerwick to 61°·9 at Margate.

The weather of the week ended June 29th was generally cool and unsettled, with much rain and many thunderstorms. Temperature was above the average in Scotland, N., and England, N.E. and E., but below it in all other districts except Scotland, E., where it was normal. The extremes recorded, however, were neither so high nor so low as in the preceding week, the highest readngs recorded being 78° at Margate, 76° at Greenwich, and 75° at Gordon Castle, Yarmouth, Geldeston, and Camden Square; and the lowest 40° at Balmoral, and 41° at West Linton. No frost on the ground was reported, the minimum on the grass being 34° at Crathes and at Hampstead.

The soil temperature at one foot depth was above the average; but at four feet depth the excess was small, and in some parts of the country it was slightly in defect.

Rainfall was in excess in all districts except Scotland, N., where it was in defect.

In England, S.W., and in Ireland, S., the totals were more than three times as much as usual. At Arlington, N. Devon, the amount collected during the week was 3·46 inches, as compared with an average of 0·78 inches. At Westminster the total did not quite reach half an inch.

Sunshine was in defect very generally, but in England, S.E., and the English Channel it was slightly above the average. The sunniest district was the English Channel with a daily average of 8·8 hours (55%), while in Scotland, N., and Ireland, N., the mean daily value was only 3·9 hours (23%). The sunniest stations were Guernsey, 10·2 hours (64%), and Weymouth 9·2 hours (57%).

The temperature of the sea water round the coasts ranged from 50° at Lerwick and Berwick, to 63° at Margate and Teelin, and 66° at Seafield.

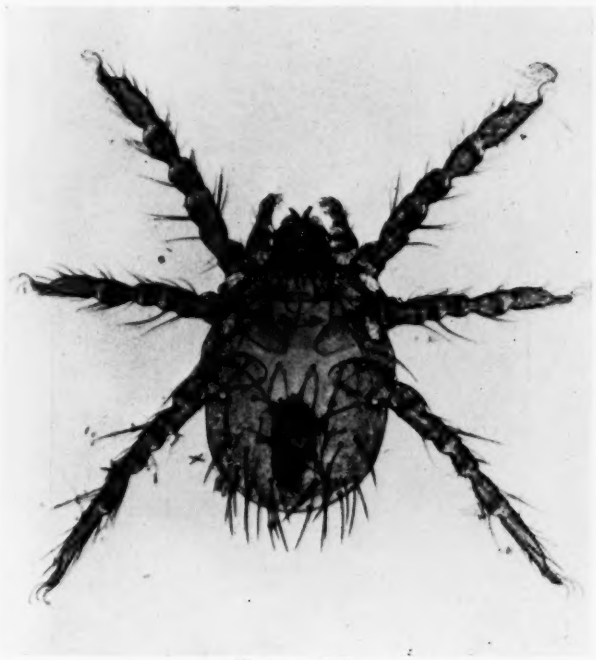


FIGURE 351.
The six-legged stage of a Harvest Mite × 150 diameters.

MICROSCOPY.

By F.R.M.S.

HARVEST-MITES.—The hot dry days of last summer were particularly favourable to these minute pests, and holiday-makers in many districts must have suffered from their attacks, probably without ever catching sight of their tormentors. Harvesters or harvest-bugs are a species of grass-mite; they are bright red in colour, and the body alone is about one seventy-fifth of an inch long. The photomicrograph shows the six-legged stage magnified one hundred and fifty times. It will be seen that it has rather a formidable-looking beak, and that its legs, which are about as long as its body, are each armed with three claws. The mites are difficult to detect on the human skin, but can be easily seen on a sheet of white paper; specimens can be obtained by putting a sheet of paper under long grass and beating the grass with a stick. The harvesters will be seen as quickly-moving red specks, and can be caught on the tip of a fine camel's hair brush previously moisted with water or spirit.

ERNEST MARRIAGE, F.R.P.S.

LOW POWER PHOTOMICROGRAPHY—LIGHTING AND BACKGROUNDS.—In photomicrography generally, and perhaps especially in the domain of low power work as used by naturalists, I would be inclined to say that success, like a three-legged stool, depends on three supports, *viz.*, (1) focusing, (2) lighting (including backgrounds), (3) exposure and development.

In this note I propose, as briefly as may be, to offer a few general suggestions on the topic of lighting and backgrounds, for the benefit of the busy worker who wants to get at the heart of the matter as directly as possible in its practical application, and without going through the mill of trial and error. At the same time, be it said, to anyone disposed to

make a few quite simple experiments the slight trouble involved would be well repaid.

With a view to simplifying matters I select four small shells, which are here shown magnified about three diameters, to illustrate four typical classes of such subjects.

On our right a *smooth*, shiny, white shell (A); to the extreme left a yellowish-gray, *rough* shell (B); at the top a moderately smooth-surfaced specimen, showing red and yellow *markings* (C); below a specimen having a slightly ribbed surface, and also a portion where the outer layer has broken away, laying bare the *iridescent* nacreous layer (D).

By a pin's head touch of seccotine these specimens are affixed to a piece of matt surface (so called) black paper, which in turn is pasted on to an ordinary micro-slip.

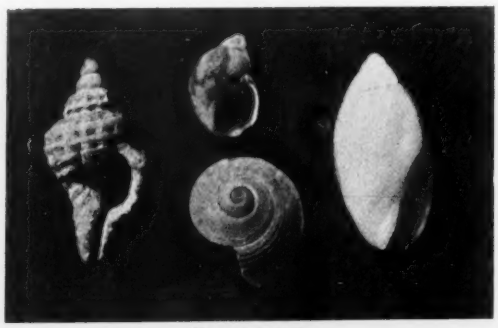


FIGURE 352.

It is not unnatural to think the stronger the light the better will be the result. Figure 352 shows the effect of a strong direct sunlight falling sideways on the object from a narrow window on our left. In this case we get a loss of detail in the strongly-lighted parts and intense cast shadows, both undesirable features; but we may note where this sidelight catches small prominences, in B or D, for instance, we get the contrast effect due to cast shadow—a point worth remembering for occasional use. Moving the object just out of the path of direct sunlight, yet retaining side illumination, we get the effect shown in Figure 353. Again the contrasts are strong, but the shadows are not so sharply defined. On the whole this scheme of lighting is preferable to the first method, as it gives us the one advantage of the first method without its two other disadvantages. This print has purposely been made rather too contrastful by over-developing the negative, with the idea of drawing attention to this very general fault with this lighting.

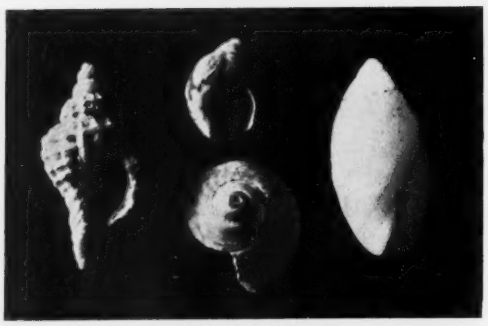


FIGURE 353.

In the next example (Figure 354) the apparatus was revolved so that the window lighting was midway between a "side" and a "back" lighting. It may be noted that the cast shadows on the background are less wide than in the second position; the surface details in B and D are better rendered in every way by delicate contrasts of light and shade; the roundness and surface-glinting, reflectinglight of A indicate its form and surface. Colour contrasts in C are here better shown. All things considered, this is the most generally useful lighting apart from special effects required. Figure 355 gives us the effect of light from a large window falling on the object from behind, *i.e.*, over the top and at both sides of the camera.

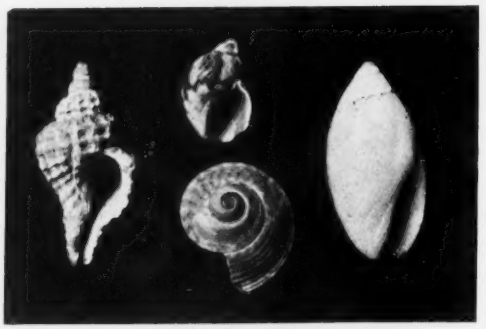


FIGURE 354.

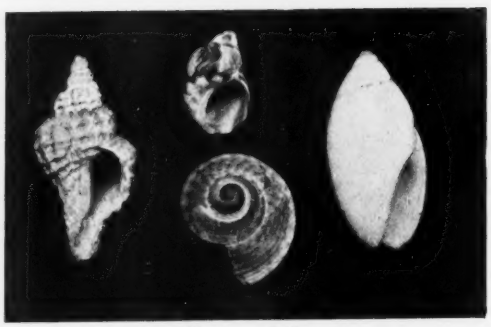


FIGURE 355.

This is a very common, but very seldom satisfactory, plan. The common notion is "the more light the better," but one may recall the pregnant saying of William Hunt, the artist, "There is only one way to have light. Have darkness to make it on. Nothing exists without a background." Most photographers when photographing a cathedral or even a human being recognise the necessity for both light *and* shade, but when dealing with little things shade is forgotten. Flooding a small object with light does not necessarily bring out character. In Figures 354 and 355, for example, we may compare the rendering of the delicate surface ribbing on specimen D, noting how the shadows cast by these ridges in Figure 354 show far more character than in the back-lighted example (Figure 355).

Doubtless the reader has noted that I said we were here using matt surface, *i.e.*, non-shiny black paper, but that in the accompanying figures the background looks rough, coarse-grained and anything but uniformly black. One may notice that in Figure 352 we get a very noticeable difference between the sunlit and cast shadow parts of this black paper. As one would naturally expect, we get least granulation with a back lighting, Figure 355, when the incident light falls into the tiny valleys of the paper surface, and most surface indication in Figure 352 when the strong side light throws cast shadows from the little elevations of the paper surface. It should not be forgotten that while we are enlarging the images of the shells we are at the same time enlarging the surface grain of the paper. And, further, when this background is in fairly sharp focus, one is tempted to notice this enlarged granularity. Later on something further may be said about focusing and definition, but not to distract the reader's thoughts from the lighting topic it may suffice for the moment to say that our general aim should be to get the object in sharp focus but to let its background be slightly *less* sharply defined. This for two reasons. The difference of definition helps the idea of different distances and so aids modelling, relief, and roundness. Also, as the eye naturally is attracted by those parts of the picture which are in sharpest definition, the sharply focused object gets more eye attention than the less sharp background, which is as it should be. The beginner will find it a great help

in choosing his scheme of lighting to view the object from just over the top of the camera and looking at it through a piece of rough black paper rolled up to form a viewing tube when held close to one eye.

F. C. LAMBERT, M.A., F.R.P.S.

PHOTOGRAPHY.

By EDGAR SENIOR.

THE USE OF PROJECTION OCULARS IN PHOTO-MICROGRAPHY.—In our article on low power photo-micrography in the June issue of "KNOWLEDGE," we showed examples taken by means of the objectives only, making use of the extreme camera extension available, "one hundred and sixty-three centimetres," in obtaining the magnifications given. If, however, it be desired to still further increase the size of our image, in order to render visible detail too small to be readily seen by the unaided eye, then resort must be made to the use of an ocular ("eye-piece") as well. A deal of diversity of opinion exists as to whether the ordinary oculars employed for visual observation should be used in photographing. We ourselves have obtained excellent results with them. For great magnification, the compensating oculars used in conjunction with apochromats will be found to work well with modern achromats. There can be no doubt, however, that wherever possible it will be advisable to employ a projection ocular, for although primarily intended for use with apochromatic objectives, they give excellent results with achromats. This eyepiece consists of a collective lens, and a triple projection combination at the other end of the tube, and the former, "when the specimen is in focus," forms, in combination with the objective, an image of the object in the plane of the eyepiece diaphragm. The edge of this diaphragm is then sharply focused upon the ground glass screen by means of the focusing collar in which the projection lenses are set. If attention be paid to this, an exquisitely sharp image should result. One drawback to these oculars lies in the great restriction of the field, so that it is impossible to use them for any object at all large. The illustration (see Figure 356) is from a negative taken with a one-inch objective of Messrs. James Swift & Son, together with a four-projection ocular of Messrs. Zeiss. The magnification due to the objective alone was eighty diameters, and this multiplied by four, "the value of the ocular," gives a total magnification of three hundred and twenty diameters, due to the combination of objective and eyepiece together. The exposure given was six minutes, calculated from the square of the increased magnification due to the eyepiece. The plate employed was an Imperial N.F. of speed two hundred and twenty-five H and D, and a green screen was used, as before, to give greater contrast. The negative was developed with pyro and soda developer, containing one grain of potassium bromide in each ounce of solution.

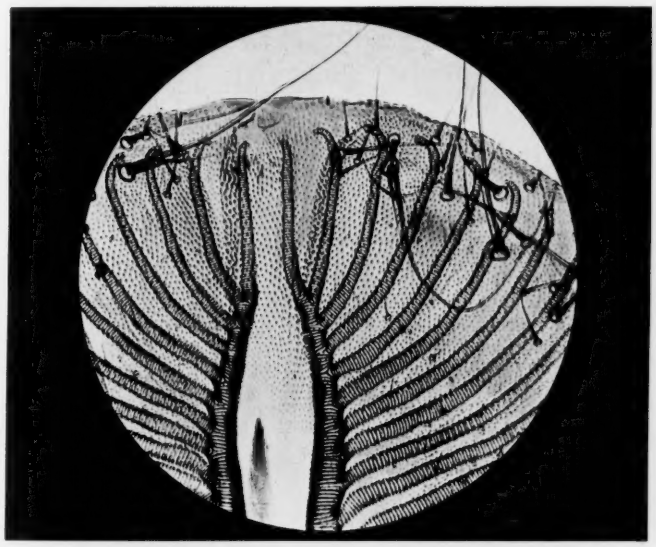


FIGURE 356. Portion of the Proboscis of a Blow-fly.

Photographed with Swift & Son's 1-inch objective and a 4-inch projection ocular of Zeiss. The original was magnified 320 diameters, and is reproduced half-size.

PROCEEDINGS OF THE OPTICAL CONVENTION. I.—COLOUR PHOTOGRAPHY.—A paper entitled "The micro-spectra method of colour photography," by Julius Rheinberg, F.R.M.S., deals with a means of producing images in the colours of the objects by photography, without the use of colour screens, coloured pigments or particles, or any device of this nature. It is a one plate, one exposure method, the image, which is black and white, being developed in the ordinary manner. The principle is one of optical synthesis, in which the blending of spectrum colours produces the sensation of white light upon the retina, when if by any means the proportion in which the colours are mixed be altered, the resulting effect is no longer of white but of colour. The method that has been adopted to carry out practically the principle involved, is most ingenious. It is well known that if a narrow slit in an otherwise opaque screen be illuminated by white light and an image of it focused upon a screen, the interposing of a prism results in the formation of a spectrum image of the slit, but if instead of a single slit a number be employed, then a number of spectrum images results. The authors of this process of colour photography have taken advantage of this in designing a screen, having four hundred slits per inch, the ratio of which to the opaque spaces is in the proportion of one to three, and by the use of a prism with small dispersion they have been able to obtain a distinct and separate spectrum with each slit. The photographic objective used in the camera magnifies the images of the slits four times. The result is a series of regularly repeating spectrums side by side, without any intervening gaps between them, and practically without any overlap, of one hundred per inch. And since the individual colours cannot be separately distinguished the sensation of white light results from their optical combination. In taking a photograph, the image of the coloured object is projected on to the line screen by means of a lens; the line screen and image are then focused on to the ground glass screen of the camera by means of a second lens with the analysing prism in front of it. The plate employed in taking the negative must, of course, be a panchromatic one. From the negative obtained, a positive transparency is made, and this, when placed in the camera "in the exact position occupied by the negative and illuminated by white light," will, by means of the deposit of silver forming the image, so remove from the white light those constituents not active in taking the negative image that the remainder will impart the colours necessary. If, for instance, red and green light had impressed themselves in the negative, these parts would be transparent in the positive, and the red and green would optically form yellow. This process of colour photography appears to be a most fascinating one. The paper is full of the most interesting problems, and the authors deal at some length with the various difficulties encountered. A normal spectrum such as is given by a diffraction grating was desirable, and a prism to give this result was computed by Mr. Conrady, of Messrs. Watson & Sons.

II.—PHOTOGRAPHIC LENSES.—In a paper on the transmission of visible light by photographic lenses, by R. W. Cheshire, B.A., the author occupies himself with some experiments carried out at the National Physical Laboratory, on the loss of light due to reflection and absorption by the glass composing the objectives. For a surface that has not been

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recently polished, the amount of light reflected normally was found to be four per cent. But it was to the loss due to absorption of light by the glass composing the lens that the experiments were mainly directed, and it was thought that it might be possible from the results obtained to establish a general empirical formula, by which the transmitting power of a lens might be estimated merely from a knowledge of the number of glass-air surfaces in the lens, and the axial thickness of the glass from which it was made.

The method employed was to compare photometrically the intensities of two beams of light: in the one case when the photographic lens to be tested is inserted in the path of one of them, and in the other when the lens is withdrawn. The source of light was a Nernst lamp, the filament of which was focused upon a small circular opening placed at the principal focus of an achromatic telescope objective of about eighty centimetres focus. This gives a parallel beam of light which falls upon one side of the diffusing screen of a Lummer-Brodhun photometer. The other side of this screen is illuminated by means of a glow-lamp enclosed in a light-tight box. In order to counteract the yellowness of this glow lamp, a circular disc provided with openings carrying a number of tinted glasses which are able to be rotated in front of the lamp is provided, and by this means the colours of the two light sources can be matched. When taking readings, the lens to be tested is placed on a support, and an auxiliary lens (employed to obtain a patch of light of a convenient size) moved along in its holder until a circular patch of light of a useful size is obtained on the diffusing screen of the photometer. The distance of the comparison lamp (glow lamp) is then adjusted until the field of view seen through the photometer is symmetrically illuminated. Several readings are taken and the mean distance of lamp from the screen noted. The lens to be tested is then removed and a similar set of readings taken with the auxiliary lens in position only: whose effect may be neglected, since it is present in both cases. From results obtained, tables have been made showing the percentage transmission of light for twenty-four objectives tested. These tables are arranged under four headings according as the number of glass-air surfaces are four, six, eight, or ten. The author also points out that the percentage transmission in any particular case can be found approximately by the following rule. For each glass-air surface allow for the loss due to reflection 5·22 per cent. of the light incident on that surface, and for the loss due to absorption allow 2·4 per cent. of the light incident upon the lens for each centimetre of the axial thickness of the glass composing the lens. The following is given of a case in point:—Consider a lens having eight glass-air surfaces in which the total axial thickness is 2·8 centimetres. At each glass-air surface 5·22 per cent. of the light is reflected and 94·78 per cent. only transmitted. Therefore, if reflection only were the cause of the loss of light, the amount transmitted would equal $(\cdot 9478)^8$ of the incident light, or 65·1 per cent. But there is the loss due to absorption as well, which in this case amounts to "2·8, the thickness in centimetres, $\times 2 \cdot 4$ per cent., the loss due to absorption of the light incident upon the lens," and this amounts to 6·7 per cent. The final value of the transmitted light, therefore, amounts to only 58·4 per cent., *i.e.*, 65·1 − 6·7. The author states that the observed value was 58 per cent., the error, ·4, being due to the difference between the percentage transmission calculated by this rule and that actually observed. The paper is a most valuable one, and will be found well worth careful consideration by those interested in the subject.

III.—PROOF PLATES.—An interesting exhibit of test plates used in checking the polishing of lens surfaces and made to an accuracy of 1·4000 of a millimetre was exhibited by Messrs. J. H. Dallmeyer, Ltd., of Denzil Road, Neasden; those used in testing plane surfaces showing broad bands instead of wide rings. The same firm also showed the various stages through which their well-known stigmatic lens passes during the course of manufacture, as well as finished examples of their series II. stigmatics, which really comprise four lenses in one, for they can be used complete as a rapid anastigmat, and the single components are corrected for use alone, each giving a picture on a larger scale than the complete lens. And, further, as the latter can be used successfully on a larger plate, it becomes a wide-angle lens as well. There were shewn the latest fixed focus telephoto lenses working with large apertures, so permitting of instantaneous exposures and giving images from two to five times that given by ordinary lenses at the same extension, *e.g.*, the Adon, a small complete telephoto lens covering plates up to fifteen inches by twelve inches, and giving magnifications of from two to four, six, ten and higher diameters. An iris diaphragm shutter of maximum opening, showing the greatest aperture it is possible to obtain consistent with closing in this form, after a paper communicated to the Optical Society by Cyril B. Lan-Davis, F.R.P.S., was on view. The maximum opening theoretically obtainable is 88 per cent.; with this form, 76·5 per cent. of the total diameter is utilised. The same firm also exhibited a series of large prisms, in one of which the effect of uneven cooling was distinctly visible as striae or veins. On Saturday, the 22nd of June, a number of members of the Convention visited Messrs. Dallmeyer's works, and were greatly interested in seeing the various processes through which photographic and other lenses pass, and the methods employed in the manufacture of optical instruments. The party included Messrs. F. B. Vinycomb, Alex Mackenzie, B. H. Parker, J. Hartley Perks, James Robert Milne, James Grundy, J. W. Ogilvy, A. E. Charlton, F. W. Edridge-Green, C. B. D. Macklow, and Mrs. C. Macklow.

EXPOSURE TABLE FOR AUGUST.—The calculations are made with the actinograph for plates of speed 200 H and D, the subject a near one, and lens aperture F.16.

Day of the Month.	Condition of the Light.	Time of Day.			
		10 a.m. and 2 p.m.	8 a.m. and 4 p.m.	6 a.m. & 6 p.m.	5 a.m. and 7 p.m.
Aug. 1st	Bright	·09 sec.	·13 sec.	·3 sec.	·63 sec.
,, ,,	Dull	·18 ,,	·27 ,,	·6 ,,	1·27 ,,
Aug. 15th	Bright	·1 sec.	·15 sec.	·42 sec.	1·8 sec.
,, ,,	Dull	·15 ,,	·3 ,,	·82 ,,	3·7 ,,
Aug. 30th	Bright	·12 sec.	·18 sec.	·6 sec.	3·3 sec.
,, ,,	Dull	·24 ,,	·36 ,,	1·2 ,,	6·6 ,,

Remarks.—If the subject be a general open landscape, take half the exposures given here.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

THE CHEMICAL EFFECT OF X-RAYS.—The ultra-violet rays are well-known to have considerable effect in causing chemical changes to take place; there are many instances of isomenic charge: of oxidation and reduction which take place more rapidly under the influence of these rays. It is interesting to find, therefore, that the X-rays have similar effect. Dr. Russ and Mr. Colwell have found that starch solutions are slowly converted into dextrin under the action of the X-rays. Kernbaum has found that X-rays do not decompose water, like the rays of radium are found to do, producing hydrogen and oxygen, so that the effect of the X-rays on the starch molecule must be a direct one.

Sir William Ramsay has confirmed the result that niton (or radium emanation) produces neon and helium in presence of water, both by direct experimental evidence from the analysis of gases pumped off from water exposed to a dose of niton for two years and also by the observational evidence that Bath waters, which are radio-active, contain a very large quantity of neon compared with the quantity of argon present; the gases from the waters of Bath contain a considerable quantity of helium also, but an even larger quantity of neon.

It is an exceedingly interesting fact that the decomposition of niton in solution gives niton and helium, while in solid minerals, and so on, it only gives helium. Is the niton a kind of polymerised helium? or is it produced by the action of

charged helium atoms on oxygen of the water? These are questions which are immediately raised by this interesting work.

THE NATIONAL PHYSICAL LABORATORY.—Volume VIII of the "Collected Researches of the National Physical Laboratory at Bushey Park" contains many researches of great interest and high value. Dr. Kaye has succeeded in constructing a standard metre of silica. Dr. Stanton has measured the shearing stress in the flow of air through pipes at speeds which cause the air to be in a turbulent condition, and the frictional resistance at the surface to be proportional to the square of the velocity. Dr. Rosenhain and Mr. Archbutt have carried out an interesting research on the alloys of aluminium and zinc which prove to be very complex. Messrs. Melsom and Booth have investigated the heating of electric cables, which work will be valuable commercially. Dr. Harker and Mr. Higgins have investigated the methods of taking the "flash point" of oils, and find that the temperature of the oil and vapour interface is the important factor. The results of work with the Froude water tank and the frictional resistance of air connected with matters dealing with stability of ships and aeroplanes are advancing satisfactorily. The visibility of lights, electrical measurements, specific heat of metals, and many other subjects, are included in the work of the laboratory as set forth in the Report.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

STRANGE HOMES FOR EARTHWORMS.—In searching for Lumbricidae on the Alps, Dr. Robert Stäger followed the useful plan of looking in unlikely places. In the mossy cushions which often flourish on the stem and branches of the sycamore (*Acer pseudoplatanus*) and bear ferns and various flowering plants, he found four species of earthworms,—*Helodrilus* (*Dendrobaena*) *rhenani* Br., *H. rubidus* Sav. and the variety *subrubicundus* Eisen, *Lumbricus rubellus* Hoffm., and *Eisenia alpina*. In cushions formed on almost bare rock by plants like *Dryas octopetala*, *Silene acaulis*, and *Gypsophila repens*, he found other earthworms. His facts afford interesting illustrations of the insinuation of life into every vacant niche.

TEETH OF SHREWS.—It is well-known that ordinary placental mammals with various types of teeth (heterodont, that is to say) never have more than three pairs of incisors. Thus there is a gap between them and the old-fashioned Polyprotodont Marsupials, such as the Tasmanian Wolf or Thylacine, which has four upper incisors, and the Bandicoot (*Perameles*), which has five. A recent study of the development of the teeth in Shrews by Augusta Ärnbäck-Christie-Linde has revealed many interesting points, one of which is the presence of more than three incisor germs in both jaws of *Sorex araneus*, and probably also in the upper jaw of *Neomys*. These extra incisor germs in the Shrew are vestigial structures without any function; they disappear without attaining full development. "They are undoubtedly inherited from distant ancestors, which consequently were to be found among polyprotodont (and heterodont) mammals." In fact, it seems as if the Shrews bridged the gap alluded to.

FAUNA OF BURROWS.—Of recent years considerable attention has been paid to the various tenants of the burrows made by moles and hamsters and other mammals of similar habit. L. Falcoz suggests a classification of the burrow-fauna into (1) "Pholéobies," which live and develop exclusively in burrows (2) "Pholéophiles," which are often found in burrows but elsewhere as well, and (3) "Pholéoxènes," whose presence in burrows is accidental. He regards the burrow-fauna as leading on to a cavern-fauna. In burrows of mole and badger he has found numerous beetles and flies, not including parasites belonging to the burrower and occasional inmates. The Myriopods, Arachnids, and Thysanura which abound in the mole's nest in winter are occasional guests, except perhaps the notably lucifugous species *Lephthyphantes alutacius* E. Sim, *Chelifer phaleratus* E. Sim, and *Japyx solifugus* Halid. As true members of the burrow-fauna may be mentioned the Staphylinid beetles, *Heterops praevia*, *Oxypoda longipes*, *Aleochara spadicea*, common in the abode of moles, likewise the Silphid beetle *Catops nigrita* and the Dipterous fly *Lycoria nervosa*.

SMELL IN FISHES.—It is probable that different fishes are attracted to their food in different ways, some being appealed to by the eye chiefly, others being susceptible also to odours and chemical stimuli. Professor G. H. Parker, has made many interesting experiments with the common American Killifish (*Fundulus heteroclitus*) which show that in this case smell counts for much. He wrapped up pieces of dogfish in cotton cloth, and the Killifishes in the aquarium competed keenly for the packets. They also seized empty packets, but they did not remain long about them. Other experiments proved that the fish uses its olfactory apparatus as an organ with which to scent its food; *i.e.*, "its olfactory apparatus is a distance-receptor of very considerable importance in its daily activities."

WEB-SPINNING PSOCHID.—Mr. E. Ernest Green calls attention to a Ceylonese Psochid (*Archipsochus*) which produces spider-like webs on trees. While silk-spinning is common among larval insects, "the power of producing silken webs is extremely rare amongst adult winged insects, and appears to be confined to certain species of the lower and more archaic families of the order Neuroptera. The Psochid in question produces silk at all stages of growth. The filament is emitted from near the mouth and is carried back between the legs of the insects. As they wander about they leave a trail of silk behind them and cover whole trees with their web. It looks like a snare, but it is probably protective. The insects usually rest during the day on the bark beneath the web, probably feeding on minute Algae and moulds.

HABITS OF GLOWWORMS.—Mr. Elmhirst, Superintendent of the Biological Station at Millport on the Clyde, has recently made some interesting observations on glowworms (*Lampyris noctiluca*), which are often plentiful in a rather marshy field adjoining the Laboratory. The males sometimes appear in great swarms of at least several hundreds. The females often take up and occupy a permanent position, night after night, until they mate. Male glowworms, like most insects, show a marked preference for red light, which is curious in this particular case, since the light of the female, which should be specially attractive, is at the other end of the spectrum. Mr. Elmhirst also remarks that the light of Finsen rays showed by Dr. Malcolm Laurie in the field did not serve to attract the male glowworms. "This experiment ought certainly to be tried again, and should under favourable conditions succeed in attracting the male glowworms, since the spectral analyses of Finsen rays and glowworm light are similar.

MYRMECODIA.—There has been much discussion over the significance of the labyrinthine stem-tubers of *Myrmecodia tuberosa*, a famous Javanese epiphyte. The mazy passages and caverns of the tuber are tenanted by ants (*Iridomyrmex myrmecodiae*) and it seems very difficult to get at the truth concerning the relations between the ants and the plant. Beccari thought that the ants were responsible for the labyrinth, but Forbes and Treub proved that there could be typical labyrinths in the entire absence of ants. It seems certain that the tuber is a water-absorbing and water-storing structure. Miehe has recently pointed out that some of the walls of the cavities are smooth and light brown, while others are warty and dark brown. A dark fungus grows on the rough surfaces, not on the smooth. The ants deposit their excrement on the rough surfaces; they use the smooth-walled chambers as nurseries. It is probable, Miehe thinks, that the excrement of the ants is utilised by the plants. The ants do not seem to eat anything that belongs to the plant, though what they eat is unknown. Nor do we know how far the ants are necessarily bound up with their convenient labyrinthine shelter.

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REVIEWS.

BACTERIOLOGY.

Microbiology for Agricultural and Domestic Science Students.—Edited by CHARLES E. MARSHALL. 724 pages. 128 illustrations and 1 coloured plate. 8¼-in. × 5½-in.

(J. & A. Churchill. Price 10/6 net.)

This is perhaps one of the most comprehensive books on Bacteriology, using the term in its broadest sense, that is at present available to English readers. Its production has been rendered possible as the result of the coöperation of a number of American workers, each of whom is a specialist in the particular branch of the subject on which he writes. It follows that the work covers a wide field, embracing as it does, in addition to ordinary bacteriological methods and technique, such branches as the microbiology of water, sewage and soil, milk, plants and special industries. The culture, morphology and physiology of micro-organisms is fully dealt with, and in a manner that appeals particularly to those who are called on to apply bacteriological methods to commercial or industrial processes.

Some apology is offered in the introduction for what is evidently regarded as a somewhat serious objection to a work which is the product of several hands, that there may be some inevitable repetition.

It must be admitted, however, that this fault, if it exists, is not at all conspicuous, a tribute, it may be, to the care exercised by the editor. The book may be recommended to those who wish to acquire a sound knowledge of the subject. It is none the less valuable because it deals not only with laboratory methods, such as may be found in nearly all works on bacteriology, but is devoted especially to practical applications.

J. E. B.

BOTANY.

Types of British Vegetation.—Edited by A. G. TANSLEY, M.A., F.L.S. 416 pages. 36 plates and 21 text-figures. 7½-in. × 5-in.

(The Cambridge University Press. Price 6/- net.)

Plant Ecology is one of the most interesting branches of Botany, and is also one of the youngest, its emergence as a definite department of the study of plant-life being of quite recent date. Ecology is more or less closely related to plant-geography on one hand, and to plant-physiology on the other. The study of plant-geography in the wide sense goes back at least as far as Humboldt's time, and is concerned with the compilation of a list ("flora") of the species growing in larger or smaller areas and with the division of the earth's surface into "floristic" areas according to the number of species, genera, and families common to them. In a broad sense, the object of physiology is the study of the external factors of the environment in which the plant lives, and of the activities and structural adaptations of the plant itself—the former are the causes, and the latter the effects of these causes. However, the scope and objects of Ecology are distinct enough from those of floristic plant-geography as well as from those of plant-physiology, and it may be defined as the detailed and systematic study of plant-communities, in their relations to each other. A plant-community is simply a grouping of certain kinds of plants which are always found associated together under definite conditions of life, or—to quote from the introduction to the book under review—it is "a vegetation-unit regarded as an aggregation of species and individuals instead of as a division of the whole vegetation of the region."

This book, which contains numerous photographic illustrations, well selected and admirably reproduced, in addition to useful maps and diagrams, is the work of several authors, but so skilfully has the difficult task of the editor (also himself largely a contributor) been done that the work presents all the obvious advantages of this plan without any of the drawbacks that it might have involved. The result is a work which not only marks an epoch in the study of vegetation, but is also absolutely indispensable to all students of the British flora who wish their studies to extend beyond the mere collecting and naming of plants. The book will prove of the greatest value to the increasing number of field-botanists in this country, to lovers of Nature, to students of scientific geography, and to everyone interested in plant-life. It should certainly be on the shelves of every school in which Nature-study is taught, and should become an essential companion to the "flora," field note-book and pocket-lens on botanical excursions—fortunately, the form of the book is well adapted for pocket use, though an india-paper edition would be welcome when the book comes into general field use, as it undoubtedly will.

Following the editor's concise and clear introduction on the units of vegetation and their relationships and classification, the work falls into two parts. The first part (forty-seven pages) deals with the physical characters, climate, and soils of the British Isles, and is mainly the work of the editor, though Dr. W. G. Smith contributes the section on Scottish soils, and Professor Grenville A. J. Cole that on Irish soils. This part of the book serves as a necessary preliminary to the detailed study of the vegetation, and also forms in itself an admirably terse, fresh, and interesting presentation of these physiographical subjects, and as such is well worth careful perusal by students and teachers of Geography.

The second part, comprising the remainder of the book (over three hundred and sixty pages), presents in detail the existing vegetation of the British Isles, and is prefaced by the editor's general account (Chapter I) of the distribution of the vegetation. This is followed by fourteen chapters dealing with the plant formation of clays and loams, the vegetation of the coarser sands and sandstones, the heath formation, the plant formation of the older siliceous soils, the vegetation of calcareous soils, aquatic vegetation, the marsh formation, the vegetation of peat and peaty soils, the vegetation of the river valleys of East Norfolk, the moor formation (lowland moors, upland moors of the Pennine Chain), arctic-alpine vegetation, and the vegetation of the sea coast. In these chapters the editor has had the collaboration of various botanists, who have made special studies of certain areas, the chief contributors being Miss Pallis, Dr. Smith, Dr. Moss, Professor Oliver, Dr. Lewis, and Dr. W. M. Rankin. Throughout this second part of the book one realises that the editor has, in addition to his own contributions, performed with entire success the difficult task of arranging and co-ordinating the various sections including material from very many sources.

As an example of the way in which the plant formations are dealt with in this work, we may select one of the most familiar, yet one of the most interesting of all—the heath formation. The heathlands of Britain, and of north-west Europe as a whole, are typically developed on poor sandy and gravelly soils, where the climate is wetter than that which, to the extreme east of Europe, gives rise to steppe; on the other hand, moorland is developed in regions of high rainfall, but also on the sites of old lakes or where surface-water poor in mineral salts has accumulated. The typical heath areas are treeless, and the dominant plants are the dwarf shrubby members of the "heather" family; the ling (*Calluna vulgaris*) is by far the most widespread and abundant species, and with it are associated bell-heath (*Erica cinerea*) and bilberry, and

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(in damp places) cross-leaved heath (*Erica tetralix*)—these four Ericaceous species are the most abundant, but many characteristic plants are associated with them. In constantly wet places—for instance, where owing to local hollows the ground-water reaches the surface and a bog is formed—peat may accumulate to a greater depth than on the dry heaths, and owing to its acid character there occur many species of the moorland formation, though in very different proportions.

In this book, however, the various formations are not treated merely as isolated elements in the vegetation; the relations of the different formations to each other are indicated, and the processes by which one formation passes over into another are fully illustrated, with references to localities where such changes may be clearly traced. Heathland has in some cases arisen *de novo* on the poorer sands, as can be seen in various areas where lichens and mosses form a layer of peat and act as pioneers for the typical heathland vegetation. In many cases, however, it is certain that the heath formation has arisen as the result of the degeneration of woodland; this process may either have taken place in prehistoric times, or may be actually going on at the present day. The heath formation is in many districts constantly and successfully invading and eventually replacing the natural woodland of sandy soils. The main cause appears to be the gradual impoverishment of the soil by washing-out when the rainfall is twenty-eight inches or more; the typical plants of the wood-"floor" are starved and give way before the invasion of heath-plants; the roots of these invaders mat together the surface soil layers and prevent the access of oxygen, and this leads to the accumulation of "acid humus" or "dry peat" in place of the original mild humus of the woodland soil. Thus we have the formation of a type of wood with a heathy vegetation, poor in species, on a soil composed of sand and dry acid humus or peat; and finally the roots of trees are either prevented from obtaining sufficient food owing to the continued washing-out of the soil, or are prevented from growing deeply enough owing to the formation of a hard layer of sand ("moor-pan") bound together by humous compounds, and the trees themselves die out, so that the woodland is replaced by heath. On the other hand, in some areas the heaths are being colonised by self-sown pine-seedlings, so that here we have a process of natural afforestation of treeless heathland.

Fine areas of heathland, where these processes, as well as the actual heath vegetation, may be well studied, occur in various parts of the country, and—as in the case of the other formations described in the book—readers will find detailed references to localities for such studies in whatever part of the British Isles they may be residents or visitors. For instance, around London and within easy reach on the "Surrey side" we find fine heath formations, with illustrations of the degeneration of woodland, encroachment of heath vegetation, the oak-birch heath association, sub-spontaneous pine-woods, and so on; special mention may be made of the heaths developed on the Lower Greensand, Bagshot sand, and the overlying plateau gravels, at various points between Dorking and Leith Hill on the east and Oxshott and Weybridge on the west.

However, it is unnecessary to indicate further the nature of the contents of this book, which should be obtained by everyone interested in plant-life. The names of the editor and his collaborators are sufficient guarantee for the quality of this "account of British vegetation from a standpoint which has not hitherto been adopted in any general treatment of the plant-life of this country," for they are one and all botanists who have laid the foundations of Plant Ecology in this country, and the most important results of their labours in this field are incorporated in the book before us.

In addition to a list of recent papers on British vegetation, the book is provided with a full index of plant names and also an admirable general index. The low price of the book should help in securing for it a wide sale. The publishers are to be congratulated on their enterprise in producing so reasonably such a well got-up and splendidly-illustrated work, which would not have been dear at a considerably higher price.

F. C.

Studies in Seeds and Fruits.—By H. B. GUPPY, M.B. 528 pages. 9-in.×6-in.

(Williams & Norgate. Price 15/- net.)

The author of this book presents an enormous amount of information relating to the absorption and loss of water by seeds and fruits. In fact, one's first impression is that the book is somewhat overloaded with columns of figures and names of plants used in the author's simple weighing experiments, and one cannot help thinking that much better, if less copious, results would have been obtained had the author used a small number of plants and a microscope and a few other methods of research, in addition to "the balance and the oven, aided by a sharp knife and a pocket lens." There is no doubt, however, that the author has made a most extensive contribution of facts to a subject which has been but little investigated, and has also suggested various lines along which further research is desirable. Moreover, packed though this book is with facts and figures, it is extremely interesting and readable on account of the author's interpretation of the facts and the speculations which he bases upon them, and the reader who wishes to "skip" some of the heavier parts of the book will welcome the author's considerateness in providing a concise summary at the end of each chapter.

Probably many readers will regard the twentieth and last chapter as the most interesting in the whole book, dealing as it does with "the cosmic adaptation of the seed." The main theme of this chapter is that the seed offers a clue to the conditions of life in other worlds, as contrasted with the full-grown plant which is adapted for terrestrial life only; the former points in the direction of the minimum of life's possibilities, the latter toward the freest conditions for growth. We have said that this book is packed with details, but the details are all too much of one kind; they practically all deal with simple observations on the changes in water-content of seeds and fruits during ripening. The aspects of the subject to which the author has devoted his attention are those most easily observed, and while interesting in their way, they certainly do not throw much light on the topics which the author attempts to handle in his speculations regarding the "cosmical" features of seeds. It is notoriously unsafe to build up elaborate theories on a too limited basis of fact, and the author of this work has evidently lost sight altogether of the *chemical* side of the subject. The condition of the dormant dry seed is to a large extent a matter for chemical investigation. There are only two alternatives with regard to the latent vitality of seeds—either vital processes (involving chemical changes) are still going on continually through slowly, or else all change is at a standstill. Which of these alternatives is correct has not yet been determined, and apparently can only be determined by keeping dry seeds in a vacuum and testing them at intervals during a long period, as it is proposed to do with the seeds deposited by Becquerel at the Bureau of Standards in Paris. Meanwhile, however, various chemical and physiological facts make it extremely improbable that even the protoplasm of any dry resting seeds can retain its vitality for much longer than did the veteran seeds tested by Becquerel, and found to germinate after eighty-seven years of repose in a herbarium. In the respiration of certain plants, no oxygen is taken from outside, while in the case of succulent plants respiration occurs without any carbon dioxide being given out, and—as suggested by Dr. F. F. Blackman (*New Phytologist*, vol. 8, p. 35)—it is quite possible that in the latent protoplasm, a steady though small supply of energy might be set free, without any change being caused in the surrounding medium. Such a process would of course end, after a number—probably a comparatively short number—of years, in death of the protoplasm. Again, it has of course been proved that dry dormant seeds, spores of Bacteria, and so on, can endure extreme cold, but it does not follow that no chemical changes can take place in the protoplasm of cells exposed to the lowest temperatures.

The seed is an organ of the greatest interest from many points of view—morphological, physiological, phylogenetic,

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physical, and chemical. New work on the seed from every side cannot fail to be of service in contributing to the store of knowledge concerning the evolution, structure, and physiology of the most complex organ in the vegetable kingdom. For this reason botanists will welcome Mr. Guppy's book, which shows how much can be done in plant physiology by the use of the simplest possible methods of experimentation.

F.C.

GEOLOGY.

Earth Features and their Meaning.—By W. H. HOBBS. 506 pages. 24 plates. 493 illustrations. 9-in.×6-in.

(Macmillan & Co. Price 12/6 net.)

This book gives in expanded form the substance of a series of lectures delivered at the University of Michigan. We may say at once that if the lectures were delivered as interestingly as they are written, the students had a most instructive and fascinating experience. The book deals with geological principles elucidated from the character of the different earth features as these are found in their respective environments. The book not only caters for students but also for tourists and travellers, and is intended to help them to have a keener and more seeing eye for the landscapes through which they are constantly passing. Stress is continually laid on the character-profiles of the land as due to various agents such as wind, ice, and running water, so that he who runs about the earth may read with greater ease the more significant lines in the moving landscape, and add notably to the pleasure of his journeying. To further this aim, most of the examples and illustrations have been drawn from well-known tourist routes, and suggestions concerning the itinerary of geological journeys are supplied in a long appendix.

This is a textbook with a decidedly original outlook. It differs from most others in not attempting to combine in a single text historical with dynamical and structural geology. The author applauds the tendency, rightly as we think, to treat historical geology especially as a subject in itself. The inclusion of all branches of geological science in a single textbook renders it unnecessarily encyclopaedic and repels the general reader. The book is written in an easy, pleasant style, devoid of formality, the only blemish of which is an inordinate use of the split infinitive. It is extremely valuable to students in that it presents in a popular form the latest results of research in dynamical geology; for which we are mainly indebted to American geologists. Written by an American and with most of the examples and illustrations of American origin, the book is pervaded by the wide continental atmosphere which is so needful as a corrective for the insular experience of most European geologists. As a typical example of the wider view we note that the parallel roads of Glen Roy are used merely as introductory to a fascinating account of the enormously greater glacial lakes of North America, which were the precursors of the present great lakes of the St. Lawrence basin. Glaciers and their work, past and present, occupy a little less than half the work, on the ground that glaciers have shaped most of the prominent earth features near the colleges and universities in northern North America and Europe.

The book is illustrated by twenty-four plates and nearly five hundred line drawings, many of which are extremely good. It is difficult, however, to make anything of a few of the drawings, notably Figures 110 and 209, which are too slight to be at all informative. There are appendices dealing respectively with the quick determination of the common minerals and the short descriptions of the common rocks, but it is difficult to see their use in a textbook of this kind. Moreover, they are inconsistent with the author's expressed views that geological textbooks are overloaded by attempting to deal with all aspects of the subject. Further appendices on the preparation of topographical maps and laboratory models for study in the interpretation of geological maps, describing some ingenious apparatus for this work, stand in a different category. To each chapter of the book a brief but valuable and up-to-date set of reading references is appended.

G. W. T.

The Student's Handbook of Stratigraphical Geology. 2nd Ed.—By A. J. JUKES-BROWNE, B.A., F.R.S. 668 pages. 210 illustrations. 8-in.×5½-in.

(Edward Stanford. Price 12/- net.)

Stratigraphy, even if confined to Britain alone, is now far too large a subject to be dealt with satisfactorily in the encyclopaedic textbook of geology. Hence one notes with approval the appearance of this work as indicative of the recent tendency to treat stratigraphy as a subject in itself, worthy of exhaustive and specialised treatment. The author, than whom no one is more qualified to write on British stratigraphy, has revised and partly re-written the account of the British strata appearing in the first edition; and, moreover, has added more complete accounts of the continental representatives of the various formations. While the British Isles contain a fairly complete epitome of the geological column, some parts of it are missing and others shew abnormal facies. Hence the wider view afforded by a concurrent study of the corresponding European strata is a valuable corrective for the insular notions the student is apt to get whose knowledge is confined to the British rocks alone. Mr. Jukes-Browne infuses life into his dry facts by giving a short account of the conditions of deposition and physical geography of each period, a subject he has dealt with, of course in much greater detail, in his "Building of the British Isles." The description of each system is prefaced by sections on the nomenclature and classification of the strata and on the life of each period, which is illustrated by numerous figures of fossils. At the beginning of the book are three valuable chapters on the often-neglected general principles of stratigraphy, stratigraphical palaeontology, and the literature of historical geology. The latter chapter gives a concise list of the more important works on British stratigraphy. This is supplemented by detailed reference to original work at the end of each chapter.

The author thinks there is no reason why the terms Primary, Secondary, and Tertiary should not be employed as timewords instead of the more cumbrous Palaeozoic, Mesozoic and Cainozoic, which are based on palaeontological facts. The latter terms, however, are so firmly established that we do not think the suggestion will meet the approval of the majority of geologists. On the other hand, Mr. Jukes-Browne would like to abolish another old-established term—none other than the Old Red Sandstone, which he stigmatises as a particularly awkward and unsatisfactory name. We are glad to note a good account of recent work in the Highlands of Scotland, an area with which it seems stratigraphers need to be courageous.

The book is well illustrated with maps and sections, and has an excellent index. It will be indispensable to all students of British geology as the fullest and most up-to-date account of our stratigraphy.

G. W. T.

HEREDITY.

Heredity—("The People's Books": No. 10).—By J. A. S. WATSON, B.Sc., F.R.S.E. 94 pages. 11 illustrations. 6¼-in.×4½-in.

(T. C. & E. C. Jack. Price 6d. net.)

In this book Mr. Watson has made a heroic attempt to condense into ninety very small pages a sketch of the various lines of approach to the solution of problems of heredity. That he has been able to explain so much with such remarkable lucidity in so small a space is nothing short of marvellous: yet one lays down the book with the feeling that the author has been obsessed throughout by the problem that besets the concocter of telegrams, to convey the maximum of information in the minimum of words. The chapters on Mendelism, in particular, are somewhat overcrowded, and parts of them might well puzzle a reader having no previous knowledge of the subject: but it would be impossible to deal more clearly with so wide a range of instances without demanding more space.

The best of the many good points of this carefully-written and well-reasoned book is that it emphasises more strongly

than any similar book within our knowledge the agreement, overlapping,and mutual interdependence of the statistical and Mendelian methods of investigation. Controversial subjects are treated with scrupulous impartiality, evidence being as rigorously railed off from opinion as stalls are from the pit. In fact, the book has only one fault: it is too short.

W. HOPE-JONES.

MATHEMATICS.

Tables Annuelles Internationales de Constantes et Données Numériques, Vol. I.—727 pages. 11-in.×8¾-in.

(J. & A. Churchill. Price 21/6 paper, and 24/- bound in cloth.)

This, the first fruits of the labours of the International Committee appointed by the Congress of Applied Chemistry in 1909, is a huge volume representing a vast amount of patient labour. The work is published under the patronage of the International Association of Academies, and material as well as moral help has been given by various Governments and Scientific Societies. A long list of these appears on one page. It is interesting to note that the Governments of Austria, France, Holland, Russia and Switzerland are included. The British Government and the Royal Society are conspicuously absent. The Royal Dublin Society and the Royal Irish Academy, and the Royal Societies of Canada and Edinburgh figure among the British Societies, an argument, perhaps, for Home Rule all round. To criticize a work of this kind in a review is impossible. The proof of the pudding is in the eating, and the size and varied ingredients of this particular pudding should make it a standing dish in all chemical and physical laboratories.

W. D. E.

METEOROLOGY.

Forecasting Weather.—By W. N. SHAW, F.R.S., Sc.D. 380 pages. 158 illustrations. 8¾-in.×6-in.

(Constable & Co. Price 12/6.)

Everyone is interested in the weather, for everyone is affected by it, but while the state of the weather is a matter of concern, a question of even greater importance is, What will the weather be? Most people are "weather-wise" to some extent, but in this book we have the latest and most authoritative views on the subject of weather forecasting, from the standpoint of the professed meteorologist, who is at the same time a master in physical science.

Dr. Shaw has been for the past eleven years the head of the Meteorological Office in London, but before that he was for twenty years engaged in teaching physical science in Cambridge, and he has brought to the preparation of this book the experience gained from the continuous study of weather forecasting in the light of experimental physics.

The result is a valuable volume in which the modern practice is fully detailed, and at the same time the theory on which the practice is based, and the relations that exist between the phenomena of the weather and the facts of physical science, are set out and explained.

Modern forecasting is based upon the knowledge of present conditions over a more or less wide area, and in practice these present conditions are represented by means of synoptic maps. The author, therefore, devotes his first chapters to the history, method of construction and gradual development of synoptic weather maps, and to a study of the relationships that exist between barometric pressure and wind, temperature and weather, and gives a clear exposition both of the information the daily weather map gives and of the inferences that may be drawn from it.

Some branches of science demand for their successful prosecution an expensive instrumental outfit, but this is not the case with weather forecasting, and it is shown that a barometer and thermometer are all the instruments necessary to enable one to make effective use of the weather maps issued day by day.

It has often been objected that the Official Forecasts are not sufficiently precise to be of service, and in connection with this criticism Dr. Shaw devotes a chapter to local variations of weather in relation to certain definite weather types. Some most interesting diagrams are given, showing how under the same conditions local phenomena—rainfall, for instance—will differ at different stations in the same district, and how important local knowledge is in interpreting the maps and forecasts.

While everyone is interested in weather forecasts there are certain classes of the community who are very specially concerned. Amongst these are seamen, agriculturists, aeronauts and colliery managers, to whom the knowledge of the weather conditions of a few hours ahead is sometimes all-important. In America, very special attention is given in the interest of fruit growers, to the issue of warnings of cold waves, and in our own islands the accurate prediction of night frosts, or of the probable weather in harvest, is of great importance. Dr. Shaw devotes special chapters to each of the classes mentioned, pointing out the varying needs of each, and the special difficulties the forecaster has to overcome in order to render his predictions really serviceable.

For a successful forecast it is necessary to take a wide survey, and for a wide survey it is necessary to use observations made outside the British Isles. A very real difficulty experienced by workers in Meteorology, when dealing with results obtained in different countries, is the want of uniformity in the units employed. Dr. Shaw boldly meets this difficulty by advocating a uniform system of C.G.S. Meteorological Units, the general use of which would clearly be an immense boon. It is hardly likely that the new system will be brought into general use at once, but it is a notable step forward to have developed a practical scheme and to have indicated the line of advance.

The book is well got up and is very fully illustrated with an admirable selection of charts and diagrams. Many of these are, however, on a small scale and need a lens for their proper study.

The author is to be congratulated upon the production of what probably will be the standard work on weather forecasting for many years to come.

PHYSICS.

The Energy System of Matter: A Deduction from Terrestrial Energy Phenomena.—By JAMES WEIR. 200 pages. 12 diagrams. 8-in.×5¾-in.

(Longmans, Green & Co. Price 6/- net.)

The author of this book considers that modern science is too metaphysical. In particular, he is opposed to the hypothesis of the ether of space. He argues that it is absolutely impossible to explain phenomena, that all that can be done is to describe them. After this, he proceeds to attempt an explanation of all natural phenomena in terms of matter and energy, both of which, as presented in his book, are metaphysical entities. He is, therefore, hardly consistent.

His main thesis is that "Every transformation of energy is carried out by the action of energised matter in the lines or field of an incepting energy influence." As an example of what he means by an incepting energy influence, gravity may be instanced. He argues that the planetary bodies are absolutely separated from one another, and from the sun, and that no energy is transferred from one to another. Across the empty space between them, however, gravity is operative as a passive influence. According to the author's theory, all the various forms of energy manifested on a planet are derived from the energy of its axial rotation, under the incepting influence of gravity and other similar fields (*e.g.*, thermal, luminous, and so on), and all such energy is ultimately transformed back into axial energy by means of the atmosphere. Each planet, therefore, is an absolutely conservative system.

Mr. Weir denies, of course, the existence of radiant heat, and argues that since there is, in his opinion, no transmission of energy from one celestial body to another, there is no necessity to postulate the existence of a medium filling the spaces between. But surely, even admitting the truth of his theory of incepting energy influences, if it is necessary to assume the existence of "matter" to support those phenomena which are loosely spoken of as "properties of matter," surely

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it is just as necessary to assume the existence of "ether" to support or constitute the "lines or field of the incepting energy influences." It is true, we think, that science is not concerned with the ultimate explanation of phenomena; that is the business of metaphysics. But Mr. Weir ought not to be metaphysical and antimetaphysical in one and the same breath.

The author's arguments seem very far from conclusive as to the supposed return of all terrestial energy to the form of axial energy; and what he terms experimental evidence not infrequently turns out to be merely discussions of purely hypothetical machines which cannot be constructed. Moreover, his discussion is limited to only the simplest phenomena —electrical phenomena are barely touched upon, for example. It is, further, hard to see how Mr. Weir's views can be reconciled with the phenomenon of the increase of mass of a charged particle when its velocity approaches that of light, since Mr. Weir assumes as absolutely true, the law of the conservation of inertia, which, using an inaccurate expression (now generally discarded), he calls the law of the conservation of matter.

We by no means say that Mr. Weir's book is lacking in interest, but we certainly doubt whether modern physical theories concerning matter, energy and the ether will be seriously affected by its arguments.

H. S. REDGROVE.

An Experimental Course of Physical Chemistry.—Part II. Dynamical Experiments. By T. F. SPENCER, D.Sc., Ph.D. 256 pages. 68 illustrations. 7½-in. × 5-in.

(G. Bell & Sons. Price 3/6 net.)

This book forms the second part of Dr. Spencer's book which has already been reviewed in "KNOWLEDGE." It is an even more valuable contribution to the library of the practical worker in physical chemistry. The experiments in the chapter on Mass Action will give the student clear ideas on the subject of Chemical Dynamics; the chapter on Conductivity of Electrolytes is thoroughly practical and useful. The chapter on Dielectric Constants will be useful to the advanced worker, but might have been rather more fully dealt with, the descriptions being rather sketchy. The chapters on Transition Temperatures and Radioactivity are also most useful in a small handbook of this sort. Other chapters on Transport Numbers, Electromotive Force, and Thermo-Chemistry are included. The book is bound to be much used by students and those workers who desire to make occasional physico-chemical measurements.

A. C. G. E.

A. B. C. of Hydro-dynamics. — By Lieut.-Col. R. DE VILLAMIL, R.E. 135 pages. 48 illustrations. 8¾-in. × 5½-in.

(E. & F. N. Spon. Price 6/- net.)

This book is somewhat of a controversial character, and full of quotations, criticisms and contentions. For this reason, alone, the book must be an interesting volume; but it is written also by one who possesses a grasp of the subject and an original insight into such matters as it deals with. It is a book that requires reviewing very thoroughly, if it is reviewed at all, and the writer prefers to bring it to the notice of readers of "KNOWLEDGE" without a long discussion on Hydro-dynamics, leaving it to them to form their opinion on the book. The scope of the book ranges through the following subjects: the resistance of liquids, viscosity, "stream-lines," Stokes'-law, vortices and the sensitive flame.

A. C. G. E.

Tables of Logarithms, Anti-logarithms and Reciprocals. 6 pages. 9½-in. × 6-in.

(C. & E. Layton. Price 1/-.)

These are a clear set of well-printed logarithmic tables of four figures, easy to manipulate and useful for laboratory and statistical purposes.

A. C. G. E.

Studies in Terrestrial Magnetism.—By C. CHREE, M.A., F.R.S. 206 pages. 43 illustrations. 9-in. × 6-in.

(Macmillan & Co. Price 5/- net.)

The above book is one of a series of monographs, published by Macmillan & Co., which are intended to give the results of the work of their authors in a connected form, and should prove most valuable. Professor Chree is the first authority on all matters connected with terrestrial magnetism, and the book sets out the result of his long series of researches. As he states, the book deals almost entirely with facts and the absence of any definite theory as to the origin of magnetic changes is due to no lack of curiosity as to the causes of things. The phenomena of terrestrial magnetism are of a complicated nature and the book will surely be of great interest to all those who take an interest in physical matters; for they will be shown how Professor Chree has steered his way through a very intricate field of inquiry and collected much valuable information of natural processes. Physicists will be most interested by the chapters which deal with magnetic storms, and the connection between the earth's magnetism and sunspot activity.

A. C. G. E.

NOTICES.

EDWARD SMITH.—Mr. Edward Smith, whose name was mentioned in the July number of "KNOWLEDGE," page 279, as the author of "The Life of Sir Joseph Banks," was in two places accidently referred to under the Christian name of George; a mistake which we hasten to rectify.

THE BACTERIOLOGY OF LEPROSY.—Our reviewer, in dealing with the Fourth Report of the Wellcome Research Laboratories, said that no reference had been made in it to the work of Beauchamp Williams on the Bacteriology of Leprosy. Dr. Andrew Balfour, Director of the Laboratories, writes to say that a resumé of the work in question was given on pages 166 and 167, under the heading of "Additional Notes." Dr. Balfour adds the interesting information that it is hoped at the Wellcome Research Laboratories to proceed on similar lines in preparing a vaccine for the common and crippling disease known as Mycetoma or Madura Foot. Captain Archibald, who has succeeded in cultivating the parasites from several species, has, in fact, put himself into communication with Dr. Williams on the subject.

DALLMEYER CAMERAS.—We have received a brief list of Messrs. Dallmeyer's Cameras, amongst which we notice the Carfac collapsing cameras which extend in a very simple manner, can be loaded in daylight with films, and are British made at Messrs. Dallmeyer's factory at Willesden. There is also included a special correspondent's camera which was designed for newspaper men during the South African war, and which has since been improved, as well as roll film cameras, a reflex for naturalists, and double extension stand cameras.

SCIENTIFIC BOOKS.—We would bring to the notice of our readers Messrs. Henry Sotheran & Company's catalogue, numbered 725, containing a list of more than two thousand books on mathematics, chemistry, physics and astronomy, and also their catalogue numbered 728, which contains a number of scientific books.

THE ISLE OF WIGHT BEE DISEASE.—The Board of Agriculture issued with the May number of its *Journal* a supplement consisting of over one hundred and forty pages dealing with the investigations which have been made on the Isle of Wight Bee Disease in the Pathological Laboratory, Cambridge. The infection may be transmitted through the agency of infected food or a living bee. Sometimes the stock remains healthy and the infected bees are gradually eliminated. Frequently, however, the stock suffers severely or from a mild form of the disease and succumbs. Various conditions tend to lessen the natural resistance of the bee and no permanent cure has apparently been recorded.

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